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NUREG-0683
Supplement No. 2
Final Report

Programmatic
Environmental Impact Statement
related to decontamination and disposal of radioactive wastes resulting from March 28, 1979 accident at Three Mile Island Nuclear Station, Unit 2

Docket No. 50-320

Final Supplement Dealing with
Disposal of Accident-Generated Water

GPU Nuclear, Inc.

U.S. Nuclear Regulatory Commission

TMI Cleanup Project Directorate

June 1987

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ABSTRACT

1. Proposed Action and Location:

DECONTAMINATION AND DISPOSAL OF RADIOACTIVE WASTES RESULTING FROM THE MARCH 28, 1979, ACCIDENT AT THREE MILE ISLAND NUCLEAR STATION, UNIT 2, LOCATED IN LONDONDERRY TOWNSHIP, DAUPHIN COUNTY, PENNSYLVANIA

2. In accordance with the National Environmental Policy Act, the Commission's implementing regulations, and the Commission's April 27, 1981 Statement of Policy, the Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from March 28, 1979, accident Three Mile Island Nuclear Station, Unit 2 NUREG-0683 (PEIS) is being supplemented. This supplement updates the environmental evaluation of accident-generated water disposal alternatives published in the PEIS, utilizing more complete and current information. Also, the supplement includes a specific environmental evaluation of the licensee's proposal for water disposition. Although no clearly preferable water disposal alternative was identified, the supplement concluded that a number of alternatives could be implemented without significant environmental impact. The NRC staff has concluded that the licensee's proposed disposal of the accident-generated water by evaporation will not significantly affect the quality of the human environment. Further, any impacts from the disposal program are outweighed by its benefits.

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SUMMARY

The Final Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from March 28, 1979, accident Three Mile Island Nuclear Station, Unit 2 was issued as NUREG-0683 by the U.S. Nuclear Regulatory Commission (NRC) in March 1981. That document discussed a variety of alternatives for disposal of water contaminated as a result of the accident (accident-generated water), and concluded that a decision could "... be deferred until after the water has been processed. Then the concentration of radionuclides remaining in the water will be low enough for the water to be stored safely onsite until the disposal decision is made." As a supplement to the PEIS, this document should be considered part of the earlier PEIS. For completeness, refer to the PEIS for all aspects of the NRC's National Environmental Policy Act (NEPA) review of the TMI-2 cleanup, other than disposal of accident-generated water, which is the subject of this supplement.

The initial processing to remove most of the radioactive material from the water contaminated as a result of the TMI-2 accident has now been completed, and much of the water is currently being used for cleanup, primarily for decontamination and/or shielding applications. The licensee, GPU Nuclear Corporation, has indicated, based on operational experience, that final processing prior to disposing of approximately 2.3 million gallons (8.7 million liters) will result in the following levels of activity: 1020 curies of tritium, between 0.03 and 0.29 curies of cesium-137, 0.08 to 0.9 curies of strontium-90, about 0.87 curies of carbon-14, and lesser amounts of other radionuclides. The water will also contain nonradioactive contaminants, boron, and sodium. Boron was introduced in the water as approximately 150 tons (136,000 kilograms) of boric acid. Sodium was introduced in the water as approximately 11 tons (10,000 kilograms) of sodium hydroxide.

The licensee has proposed to dispose of the accident-generated water by forced evaporation to the atmosphere, followed by onsite solidification of the remaining solids, and disposal in a commercially operated, NRC-licensed, low-level waste burial facility. The disposal volume is expected to be 40,000 to 80,000 ft^3 (1,000 to 2,300 m^3).

In accordance with the requirements of NEPA and the Commission's implementing regulations, the licensee's proposal and a number of alternative approaches were examined for their potential environmental impact.

Nine alternatives were evaluated:

1) Evaporation, solidification of bottoms, and disposal at a licensed burial site (the licensee's proposed alternative);

2) Evaporation, solidification of bottoms, and retention onsite;

3) Distillation (closed cycle evaporation), solidification of the bottoms, and disposal at a licensed burial site followed by river disposal of the condensate;

4) Offsite evaporation at the U.S. Department of Energy (DOE) Nevada Test Site;

5) Solidification and permanent onsite storage of solidified waste;

6) Solidification and disposal at a commercial low-level waste site;

7) Long-term (years) discharge to the Susquehanna River;

8) Short-term (days) discharge to the Susquehanna River;

9) Liquid storage in tanks on the Three Mile Island site.

An additional fifteen alternatives were considered but eliminated from further evaluation as being less desirable from a technical standpoint, or clearly inferior to the other alternatives that received more detailed consideration. The range of environmental impacts associated with the alternatives is summarized in Table S.1.

In attempting to identify whether any alternative was clearly preferable from an environmental impact perspective, alternatives were evaluated relative to the risk from radiation exposure both to the public and to workers, the probability and consequences of accidents, the commitment of resources (including costs), and the regulatory constraints. Alternatives were evaluated at a level of detail that is expected to conservatively bound the range of environmental impacts predicted in this report.

The estimated environmental impacts for all the considered disposal alternatives ranged from 0 to 0.003 radiation-induced cancer fatalities in the worker population (i.e., a maximum of 3 chances in 1000 that a single member of the total work force would develop a fatal cancer), 0 to 0.0004 radiation-induced cancer fatalities in the offsite population (i.e., a maximum of 4 chances in 10,000 that a single member of the 50-mile offsite population would develop a fatal cancer), and 0.03 to 0.8 transportation-related traffic fatalities in the offsite population (i.e., a maximum of 8 chances in 10 that an individual would be fatally injured). For perspective, the risk of developing a fatal cancer among the 50-mile (80-kilometer) population from water disposal near TMI, as stated above, can be compared with the risk of the expected approximately 440,000 cancer deaths from all causes in the same population. The most significant potential impact associated with any disposal alternative was identified as the risk of physical injury associated with transportation accidents.

No alternative was found to be clearly preferable to the licensee's proposed action. The total estimated impact to persons living near TMI and to the work force from any alternative is very small. While the quantitative estimates for some potential impacts (i.e., cost, long-term commitment of space, and time required) were found to vary for some of the alternatives,

TABLE S.1. Range of Impacts from the Alternatives Considered

Bone dose to the offsite population	0 to 14 person-rem total population 0 to 0.4 mrem, maximally exposed offsite individual
Total body dose to the offsite population	0 to 3 person-rem total population 0 to 5 mrem, maximally exposed offsite individual
Thyroid dose to the offsite population	Up to 6 person-rem total population Up to 4 mrem, maximally exposed offsite individual
Estimated number of radiation-caused cancer fatalities to the offsite population	0 to 0.0004
Estimated number of radiation-caused genetic disorders to the offsite population	0 to 0.002
Occupational dose	0 to 25 person-rem
Estimated number of radiation-caused cancer fatalities to the worker population	0 to 0.003
Land commitment	0 to 49,000 ft^2
Radioactive waste burial ground volume	0 to 460,000 ft^3
Cost to the licensee	$0.1 to 41 million
Time to complete	0 to 36 months
Number of traffic accidents	0 to 12
Estimated number of traffic fatalities	0 to 0.8
Maximum individual dose from accidents	0 to 60 mrem total body 0 to 3000 mrem bone
Population dose from accidents	0 to 0.7 person-rem bone 0 to 0.02 person-rem total body

these differences were not judged sufficiently large to allow for either identification of a clearly preferable alternative or rejection of any of the nine evaluated alternatives.

In addition to evaluating risks and costs, the staff concluded that there is a benefit to taking relatively near-term action to dispose of the existing accident-generated water. Ultimate disposal of the water is considered a fundamental element in accomplishing the overall cleanup of TMI-2. Relatively near-term action to safely dispose of the water would support the Commission's goal of safe and expeditious cleanup of the facility. Disposal of the water would be required in connection with ultimate decommissioning of the facility and release of the site for unrestricted use. Disposal of the water, regardless of some period of continued storage at TMI, is expected to be required since the water will remain slightly radioactive for several hundred years. The environmental impacts associated with disposal following even a relatively long period (10 to 30 years) of onsite storage are not expected to be significantly different from impacts associated with near-term disposal. Accordingly, the NRC staff further concluded that the no action alternative of extended storage of the accident-generated water in tanks on the TMI site was inappropriate, even though it would involve relatively small environmental impact. This alternative, consideration of which is required by NEPA, would not directly result in the disposal of contaminated accident-generated water. Adoption of this alternative would only postpone action, which would ultimately be required to dispose of the existing water without presenting a significant environmental advantage.

A draft supplement was circulated to allow public input to the decisionmaking process. The comments received are incorporated in Appendix A as are transcripts of statements from public meetings of the Commission's Advisory Panel for the Decontamination of TMI-2. Responses to comments received are included specifically in Section 7.0 and in changes and clarifications (designated by change bars) made throughout this final supplement. In addition, and as a result of comments on the draft supplement, three additional alternatives were considered and two previously evaluated alternatives were rejected for detailed evaluation in the final report. Both deep-well injection at the Nevada Test Site and crib disposal at Hanford, Washington were rejected on the basis of comments from DOE. Alternatives involving distillation of accident-generated water were added on the bases of comments and questions raised by persons living in the TMI vicinity. Distillation, solidification, and offsite disposal of residual solids, followed by river discharge of the distillate was evaluated in detail.

The NRC staff has concluded, based on this evaluation and after considering comments on the draft supplement, that the licensee's proposal to evaporate accident-generated water is an acceptable disposal plan. As identified in this report, evaporation of the water at the TMI site, followed by the solidification and disposal of the remaining low-level radioactive solids will not significantly affect the quality of the human environment. The staff has also concluded that any adverse impacts from the disposal program are outweighed by its benefits. Since the Commission has indicated its intent to take final agency action on any proposal for water disposition, the staff will recommend Commission approval of the licensee's proposal.

FOREWORD

This final supplement to the Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from March 28, 1979, accident Three Mile Island Nuclear Station, Unit 2 (PEIS) was prepared by the U.S. Nuclear Regulatory Commission (NRC), Three Mile Island (TMI) Cleanup Project Directorate, Division of Reactor Projects-III/IV/V and Special Projects, Office of Nuclear Reactor Regulation (referred to as the staff), pursuant to the Commission's April 27, 1981, Statement of Policy related to the PEIS and the requirements of the National Environmental Policy Act of 1969 (NEPA). Assistance was provided by the Pacific Northwest Laboratory under the direction of the staff; the contributors to the supplement are listed in Appendix B. This supplement addresses potential environmental impacts associated with the disposal of water contaminated as a result of the accident (accident-generated water).

Information for the supplement was obtained from the licensee's Environmental Report and Final Safety Analysis Report (Metropolitan Edison Co. and Jersey Central Power & Light Co. 1974), from the staff's Final Environmental Statement for the operating license (NRC 1976), from the staff's PEIS of March 1981 (NRC 1981) and Supplement 1 of October 1984 (NRC 1984), and from new information provided by the licensee or independently developed by the staff. The staff met with the licensee to discuss items of information provided, to seek new information from the licensee that might be needed for an adequate assessment, and to ensure that the staff had a thorough understanding of the proposed disposition. In addition, the staff sought information from other sources that would assist in the evaluation, and visited and inspected the project site and vicinity.

On the basis of the foregoing, the staff made an independent evaluation of the licensee's proposed action and alternatives and prepared this supplement to the PEIS. The supplement, in addition to quantifying estimated environmental impacts for disposal alternatives, addressed the NEPA-required issue of whether any alternative was clearly preferable to the licensee's proposed action from an environmental impact perspective. A draft supplement was circulated to federal, state, and local government agencies and to interested members of the public for comment. A summary notice of the availability of the draft supplement was published concurrently in the Federal Register. The original 45-day comment period was extended to 90 days at the request of the Commission's Advisory Panel for the Decontamination of TMI and several other interested persons. The information on which the supplement was based was made available to the public,(a) and all comments received were considered by the staff in preparing this final report.

(a) NRC Public Document Room, 1717 H Street, Washington, DC 20555, and the State Library of Pennsylvania, Government Publications Section, Education Building, Commonwealth and Walnut Streets, Harrisburg, PA 17126.

The following federal and state agencies were asked to comment on the draft supplement. Comments received are included in Appendix A with the comments from the public.

- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Department of Agriculture
- U.S. Department of Energy
- U.S. Department of Health and Human Services
- U.S. Department of Labor
- U.S. Department of Interior
- U.S. Department of Interior, Geological Survey
- U.S. Department of Transportation
- U.S. Nuclear Regulatory Commission, Advisory Panel for the Decontamination of TMI Unit 2
- Maryland Department of Natural Resources
- Maryland Department of State Planning
- New Jersey Department of Environmental Protection
- Pennsylvania Department of Environmental Resources
- Pennsylvania Department of Health
- Pennsylvania Department of Labor and Industry
- Pennsylvania Department of Public Welfare
- Pennsylvania State Clearing House

After receipt and consideration of comments on the draft supplement, the staff prepared this final supplement to the PEIS, which includes a discussion of comments on the draft supplement, responses to them, and updated information based on the comments. The NRC staff will also provide the Commission with a recommendation regarding the licensee's proposal to dispose of accident-generated water.

Single copies of this supplement may be obtained by writing the Director, Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

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NOMENCLATURE

accident-generated water - tritium-contaminated water, as defined in Section 2.1.

achievable concentration - a term used to define the composition of the accident-generated water following retreatment by the SDS and EPICOR II system of all of the water in storage. (See Table 2.2, page 2.3.)

AEC - Atomic Energy Commission, predecessor to the Nuclear Regulatory Commission and the Department of Energy.

Agreement States - states that have agreed to accept the responsibility of enforcing the provisions of federal legislation for activity within their borders. The Commonwealth of Pennsylvania is an Agreement State with respect to the Clean Water Act, but not the Atomic Energy Act.

alpha radiation - an emission of particles (helium nuclei) from a material undergoing nuclear transformation; the particles have a nuclear mass number of four and a charge of plus two.

ambient radiation - radiation from multiple or distributed sources.

anadromous fish - fish that ascend freshwater streams from the sea to spawn.

anions - ions that are negatively charged.

aquifer - a subsurface geological formation containing sufficient saturated permeable material to transmit groundwater and to yield economically significant quantities of water to wells and springs.

background radiation - the level of radiation in an area which is produced by sources (mostly natural) other than the one of specific interest. Examples of such sources are cosmic radiation and radioactive elements in the atmosphere, building materials, the human body, and from the crust of the earth. In the Harrisburg area, the background radiation level is about 87 mrem per year, not including any contribution from medical practice.

base case concentration - the assumed starting point of accident-generated water disposal; the stored water as it now exists and the water that is currently in use (about 40% of the total) retreated by the SDS and EPICOR II system.

BEIR - biological effects of ionizing radiation.

benthic - dwelling on the bottom of a body of water.

beta particles - an electron or a positron (a particle with the same mass as an electron but with a positive charge rather than a negative one). Usually used to refer to a particle moving at a velocity high enough to produce ions. Beta particles are commonly emitted from the nuclei of atoms undergoing nuclear transformation. Also referred to as beta radiation.

biological half-life - the time required for an organism to eliminate half of the atoms of a radioactive material taken in.

biota - plant and animal life.

boron - a neutron-absorbing element used in nuclear reactor systems to control criticality.

bremsstrahlung - secondary photon (gamma or x-ray) radiation produced by the deceleration of charged particles passing through matter.

BWR - boiling water reactor.

carbon-14 - a radioactive isotope of carbon having a half-life of 5,700 years. See also Section 2.2.4.

cation - an ion with a positive charge.

cesium-137 - a radioactive isotope of cesium having a half-life of 30 years. See also Section 2.2.2.

CFR - Code of Federal Regulations.

cfs - cubic feet per second.

Ci - see curie.

crib - an in-ground structure for the disposal of liquid radioactive waste.

cumulative occupational dose - the total radiation dose to workers; determined by multiplying the dose rate times the number of workers exposed times the length of exposure. This is expressed in terms of person-rem.

curie (Ci) - the special unit of radioactivity. Activity is defined as the number of nuclear transformations occurring in a given quantity of material per unit time. One curie of radioactivity is 37 billion transformations per second.

daughter products - the nuclides formed by the radioactive disintegration of a first nuclide (parent).

demineralizer systems - processing systems in which synthetic ion-exchange materials are used to remove impurities from water.

de minimis - a level of radiation so low as to be insignificant to either individual or population dose.

DOE - U.S. Department of Energy.

dose - a general term indicating the amount of energy absorbed from incident radiation by a unit mass of any material.

dose commitment - the integrated dose that results unavoidably from the intake of radioactive material starting at the time of intake and continuing (at a decreasing dose rate) to a later time (usually specified to be 50 years from intake).

DOT - U.S. Department of Transportation.

emergency allocation - allocation of waste disposal volume by the DOE in commercial LLW burial sites because of unusual circumstances.

EPA - U.S. Environmental Protection Agency.

EPICOR II - a filtration and demineralizer system designed to process some of the liquid radioactive waste resulting from the TMI accident. The system can be used on liquid waste containing between 1 and 100 microcuries of radioactivity per milliliter of water.

ERDA - U.S. Energy Research and Development Administration, precursor to the DOE.

etiology - the cause of disease or disorder as determined by medical diagnosis.

evaporator bottoms - the concentrate that remains after evaporation of all of water. See also page 3.3.

exposure - the condition of being made subject to the action of radiation; also, frequently, the quantity of radiation received.

fission - the spontaneous or induced disintegration of a heavy atom into two or more lighter atoms with an accompanying loss of mass which is converted into energy.

fission products - the nuclides formed by the division of a heavier nucleus, typically in a nuclear reactor. Isotopes of essentially all elements are produced by fission of fissile materials. Fission products are the main radioactive components of high-level radioactive wastes.

gal/min - gallons per minute.

gamma radiation - electromagnetic radiation of high energy (and short wavelength), emitted by nuclei undergoing internal changes. Gamma radiation has the highest energy and shortest wavelength in the electromagnetic spectrum and is capable of penetrating several inches of a solid such as concrete.

genetic effects of radiation - effects of radiation that alter the hereditary material and may therefore affect subsequent unexposed generations.

GPU Nuclear Corporation - the licensee at TMI-2, a subsidiary of General Public Utilities Corporation.

groundwater - water that exists or flows below the ground's surface (within the zone of saturation).

h - hour.

half-life - the time required for half of a given radioactive substance to decay.

Hanford, Washington - a nuclear facility near Richland, Washington that is operated by the DOE.

hectare - a metric unit of measure equal to 2.471 acres.

helium-3 - a rare, nonradioactive isotope of helium formed by the decay of tritium.

HTO - tritiated water in which one of the two hydrogen atoms has been replaced by a tritium atom (see tritiated water).

hydrofracture - the fracture of deep rocks by hydraulic pressure.

Hypalon® - a plastic membrane material, manufactured by E. I. duPont de Nemours and Company, commonly used to line earthen ponds for the containment of liquid wastes.

IMO - International Maritime Organization.

in situ - in place.

in situ vitrification - a method of immobilizing buried waste in glass by melting the host soil into a glass-like compound.

iodine-129 - a radioactive isotope of iodine having a half-life of 15,700,000 years. See also Section 2.2.5.

ion - an atom or molecule from which an electron has been removed (a positively charged ion) or to which an electron has become attached (a negatively charged ion).

ion exchange - in this document, a process for selectively removing a constituent from a waste stream by reversibly transferring ions from a liquid to an insoluble solid.

ion exchange media - resins or zeolite materials used in ion exchange processes.

ionization - the process by which a neutral atom or molecule acquires a positive or a negative charge by removal or attachment of an electron.

ionizing radiation - any form of radiation that generates ions.

isotopes - nuclides with the same atomic number but with different atomic masses, therefore having the same chemical properties but different physical properties.

keV - kiloelectron volt.

kg - kilogram.

L - liter.

L/min - liters per minute.

licensee - the holder of a license issued by the NRC to possess or use radioactive materials. In the case of TMI-2, the license is held by GPU Nuclear Corporation.

LLW - low-level waste. All radioactive waste materials that are not high-level or transuranic waste. Most TMI-2 wastes will be of this type.

μCi - microcurie (1×10^{-6} curies), a unit for measuring radioactivity.

μg - microgram (1×10^{-6} grams).

MCi - megacurie (million curies), a unit for measuring radioactivity.

Memorandum of Understanding - an agreement between the DOE and the licensee, GPU Nuclear Corporation, whereby the DOE will accept certain categories of waste from the cleanup of TMI-2, for permanent disposal, either without cost or on a cost-reimbursement basis.

MeV - megaelectron volt (million electron volts).

mg/L - milligrams per liter (see ppm).

mL - milliliter.

MPC - Maximum Permissible Concentration. The NRC-prescribed intake limit for radioactive materials (10 CFR 20 Appendix B). MPCs are expressed as average radionuclide concentrations in air or water. Different MPC values apply to the public and to radiation workers.

mrem - millirem (1×10^{-3} rem), see rem.

MSL - mean sea level.

NAS - National Academy of Sciences.

NCRP - National Council on Radiation Protection and Measurement.

NEPA - National Environmental Policy Act of 1969.

NPDES - National Pollutant Discharge Elimination System.

NRC - U.S. Nuclear Regulatory Commission.

NTS - Nevada Test Site.

nuclide - a species of atom having a specific mass, atomic number, and nuclear energy state.

occupational radiation exposure - the radiation exposure to which workers at a nuclear facility are subjected during the course of their work.

ORNL - Oak Ridge National Laboratory.

PaDER - Commonwealth of Pennsylvania, Department of Environmental Resources.

pCi - picocurie (1 x 10^{-12} curies), a unit for measuring radioactivity.

pCi/L - picocurie per liter.

PEIS - Final Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive waste resulting from March 28, 1979, accident Three Mile Island Station, Unit 2, NUREG-0683, 1981.

person-rem - the sum of the individual radiation doses (collective dose) received by members of a certain group or population. It may be calculated by multiplying the average dose per person by the number of persons. For example, a thousand people each exposed to one millirem each (1/1000 rem) would have a collective dose of 1 person-rem.

pH - a measure of the acidity or alkalinity of a water solution. Neutral solutions have a pH equal to 7. Acidic solutions have a pH less than 7. Alkaline (basic) solutions have a pH between 7 and 14. In any solution the pH equals the negative logarithm of the hydrogen-ion concentration.

population dose - the summation of individual radiation doses received by all those exposed to the source or event being considered, and expressed as person-rem. The same as collective dose.

ppm - parts per million = milligrams per liter = mg/L.

primary system - see reactor cooling system.

PWR - pressurized water reactor; TMI-2 is this type of reactor.

rad - a unit of absorbed dose of ionizing radiation. A dose of one rad results from the absorption of 100 ergs of energy per gram of absorbing material.

radiation - energy in the form of electromagnetic rays (radiowaves, light, x-rays, gamma rays) or particles (electrons, neutrons, helium nuclei) sent out through space from atoms, molecules, or atomic nuclei as they undergo internal change or resulting from particle and electromagnetic radiation interactions with matter.

radioactive decay - the spontaneous natural process by which an unstable radioactive nucleus releases energy or particles.

radioactivity - product of radioactive decay of an unstable atom.

radioisotopes - radioactive isotope (see also radionuclide and isotopes).

radionuclide - an unstable nuclide that undergoes radioactive decay.

RCRA - Resource Conservation and Recovery Act

RCS - reactor coolant system

rem - a unit of dose equivalent which is proportional to the risk of biological injury.

residue - see evaporator bottoms.

resin liners - cylindrical metal vessels used to contain the resins and/or zeolites during purification of contaminated water by ion-exchange processes.

resins - solid or semisolid products of synthetic origin used in ion-exchange processes for purification of liquids.

Roentgen (R) - unit of gamma or x-ray exposure in air. Energetic gamma rays that produce an exposure of 1 R deliver a dose equivalent of approximately 1 rem to a person.

SDS - submerged demineralizer system, a water-treatment system that uses a synthetic zeolite mineral to remove radioactive cesium from the accident-generated water.

shielding - a barrier of solid or liquid material (e.g., lead, concrete, or water) which reduces the intensity of radiation as it passes through and which can be used to protect personnel from the damaging effects of ionizing radiation.

somatic effects of radiation - effects of radiation limited to the exposed individual, as distinguished from genetic effects which may also affect subsequent unexposed generations. Somatic effects at low to moderate doses include cancers of various types.

specific activity - quantity of radioactivity per unit mass. Usually in picocuries per gram.

strontium-90 - a radioactive isotope of strontium with an atomic mass 90 and a half-life of approximately 28 years. See also Section 2.2.3.

technical specifications - limits of operation which an NRC licensee imposes upon itself as part of the licensing process. Technical specifications can only be modified with concurrence of the NRC.

TMI - Three Mile Island.

TMI-1 - Three Mile Island Unit 1. The NRC-licensed reactor operating on the TMI site.

TMI-2 - Three Mile Island Unit 2. The accident-damaged reactor undergoing cleanup on the TMI site.

total body dose - the radiation dose to the total body, including the bone and all organs, from both external and internal radionuclides.

tritiated water - water in which one or both hydrogen atoms have been replaced by a tritium atom.

tritium (hydrogen-3) - a rare radioactive isotope of hydrogen, containing two neutrons. The "normal" (most abundant) form of hydrogen has no neutrons. The half-life is 12.5 years. See Section 2.2.1.

unrestricted use - use of any area or facility without restriction because of prior contamination.

unretreated water - accident-generated water prior to retreatment.

UNSCEAR - United Nations Scientific Committee on the Effects of Atomic Radiation.

U.S. Ecology - the operator of a commercial LLW burial site on a leased portion of the Hanford Site near Richland, Washington.

vitrified wastes - radioactive wastes immobilized, or solidified, in glass.

volume reduction factor - remaining volume/initial volume.

yr - year.

__water table gradient__ - the ratio of change in water table elevation over distance.

__zeolites__ - any of various natural or synthesized silicates used to purify water.

__50-year dose commitment__ - the total radiation received from initial exposure through the succeeding 50 years.

1.0 INTRODUCTION

This section presents information on the purpose and scope of this Supplement No. 2, Final Report, to the *Final Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive waste resulting from March 28, 1979, accident Three Mile Island Nuclear Station, Unit 2* (NRC 1981); the 1981 publication will be referred to as the PEIS in this document.

The PEIS was intended to provide an overall evaluation of the environmental impacts that could result from cleanup activities at Three Mile Island Unit 2 (TMI-2), from the stabilization of plant conditions after the accident through the completion of cleanup, based on the information then available. Following the publication of the PEIS, the Commission issued a Policy Statement on April 28, 1981, indicating that the NRC staff would evaluate and act on major cleanup proposals as long as the impacts associated with the proposed activities fell within the scope of the impacts already assessed in the PEIS. The policy statement also indicated that any future proposal for disposition of water contaminated as a result of the accident (accident-generated water) would be referred to the Commission for approval.

The PEIS was supplemented in 1984 to present new information that led the NRC staff to conclude that cleanup would result in a greater occupational radiation dose than had been estimated in the PEIS in 1981. This document is the second supplement to the PEIS; its purpose is to update the information presented in the PEIS regarding options for disposing of the accident-generated water and the environmental impacts that could result. In keeping with Commission policy, this supplement was initially published in draft form (December 1986), and the comments received are incorporated into this final supplement as Appendix A.

Although disposal of the accident-generated water was addressed in the PEIS, several factors led the staff to conclude that a supplement to the PEIS covering this issue should be prepared. Since the PEIS was issued, much more specific information regarding the volume and the radiological and nonradiological characteristics of this water has become available. Because of this new information, the impacts associated with the various alternatives for disposition can now be estimated more accurately. The licensee, GPU Nuclear Corporation (GPU Nuclear), a division of General Public Utilities Corporation, has also submitted a specific proposal(a) for water disposition. This supplement evaluates the licensee's specific proposal and, in addition, provides an updated evaluation of a number of NRC staff-identified alternatives. Finally, this supplement has been prepared in recognition of the continuing public and

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(a) In this document, the submission, two letters plus attachments from F. R. Standerfer (GPU Nuclear) to W. D. Travers (NRC) dated July 31, 1986, and October 21, 1986, will be referred to as the licensee's proposal.

Commission interest in this issue. It is designed to inform the public and to provide a comprehensive basis for a Commission decision on the licensee's proposal.

Section 2.0 of this supplement presents background information on the accident-generated water and regulations potentially affecting its disposition. In Section 3.0, the potential environmental impacts of the licensee's proposal and a number of alternative disposal methods are discussed. For each of the alternatives which has been evaluated in detail, the supplement describes the systems and operations that would be required to implement the alternative, the estimated environmental impacts, an analysis of potential accidents, and regulatory constraints. The affected environment is described in Section 4.0. Section 5.0 compares these environmental impacts associated with the licensee's proposal and alternatives, and discusses the potential for human health effects. The conclusions are contained within Section 6.0. The staff's responses to specific relevant comments are presented in Section 7.0.

2.0 BACKGROUND INFORMATION AFFECTING ACCIDENT-GENERATED WATER DISPOSAL

This section discusses the origin of the accident-generated water, describes the water, and addresses the environmental considerations associated with the constituents of the water. Information on the regulatory constraints that may affect the selection of the disposal alternative is also provided.

2.1 ORIGIN, TREATMENT, AND USE OF THE ACCIDENT-GENERATED WATER

The accident left the reactor building basement covered with about 260,000 gallons (approximately 1,000,000 liters) of water to a depth of 3-1/2 feet (1.1 meters). In the two years following the accident, before water removal and treatment, water was added through primary coolant leakage and in-leakage of river water through the reactor building air coolers. In addition to the reactor building basement, the auxiliary building and the primary coolant system of the reactor contained water that was contaminated by the accident. The amount of water is shown in Table 2.1.

TABLE 2.1. Principal Sources of Accident-Generated Water

Sources	Amount, gallons
Initial Accident(a)	260,000
Primary Coolant Leakage(a)	178,000
In-Leakage of River Water Through Reactor Building Air Coolers(a)	180,000
Auxiliary Building	370,000
Primary Coolant System	96,000

(a) From Munson and Harty (1985). Additional accident-generated water has accumulated as a result of cleanup activities.

On February 27, 1980 an agreement executed among the City of Lancaster, Pennsylvania, Metropolitan Edison Company, and the NRC defined "accident-generated water" as:

- Water that existed in the TMI-2 auxiliary, fuel handling, and containment buildings including the primary system as of October 16, 1979, with the exception of water which as a result of decontamination operations becomes commingled with nonaccident-generated water such that the commingled water has a tritium content of 0.025 μCi/mL or less before processing.

- Water that has a total activity of greater than 1 µCi/mL prior to processing except where such water is originally nonaccident water and becomes contaminated by use in cleanup.

- Water that contains greater than 0.025 µCi/mL of tritium before processing. Because of this definition, other water that has been mixed with accident-generated water is now classified as such. The final volume at the end of defueling is expected to be approximately 2.3 million gallons (8.7 million liters).

Following the accident, two separate treatment systems were used at TMI-2 to remove radionuclides from this water. In one system, the submerged demineralizer system (SDS), water flows over a cesium-specific ion exchange medium, a synthetic zeolite mineral, where most of radioactive cesium is removed and replaced with nonradioactive sodium. A second treatment, EPICOR II, employs an organic ion-exchange medium similar to that used in industrial demineralizers. Both radioactive and nonradioactive cations and anions are exchanged with nonradioactive hydrogen cations, and hydroxide or borate anions. The EPICOR II removes strontium-90 and most of the remaining radioactive material except tritium, which is incorporated into water molecules. Traces of cesium-137, strontium-90, and other radionuclides remain. Both of these systems also employ particulate filters.

Table 2.2 identifies two cases for the accident-generated water. The "base" case assumes that the water currently in storage receives no additional treatment and that the water currently in use for cleanup activities, primarily in the reactor coolant system (RCS), defueling canal, fuel pool, and building sumps (approximately 40% of the total accident-generated water) is treated. The "achievable case," also defined in Table 2.2, assumes that, in addition to the treatment of the water that is currently in use, all of the accident-generated water in storage (in a number of tanks onsite) would be retreated by the SDS and EPICOR II system. The radionuclide concentrations listed in Table 2.2 are estimates based on operational experience of the SDS and EPICOR II system. Analysis of representative post-processing water samples for radioactive constituents has identified tritium, cesium-137, strontium-90, antimony-125/tellurium-125m, carbon-14, technetium-99, iron-55, and cobalt-60. Other radionuclides listed in Table 2.2 exist at or below the listed limit of detection. For the purpose of this environmental impact statement, the staff has conservatively assumed that radionuclides that have not been positively identified in the water nevertheless exist at the stated limit of detection.

In addition to the radiological and chemical characteristics discussed in Section 2.2, the accident-generated water being used for defueling contains suspended solids and has supported a nuisance bloom of microorganisms. These microorganisms and suspended solids, and any treatment to remove them are not expected to change the predictions of environmental impact associated with the various disposal options.

TABLE 2.2. Base Case and Achievable Radionuclide Concentration in the Accident-Generated Water[a]

Constituent	Base Case		Achievable[b]	
	Quantity,[c] Ci	Concentration, μCi/mL	Quantity,[c] Ci	Concentration, μCi/mL
Total volume	2,300,000 gal	-----	2,300,000 gal	-----
Tritium (Hydrogen-3)	1.02×10^{3}	1.3×10^{-1}	1.02×10^{3}	1.3×10^{-1}
Cesium-137	3.2×10^{-1}	3.7×10^{-5}	3×10^{-2}	4.0×10^{-6}
Cesium-134	7.66×10^{-3}	8.8×10^{-7}	7.7×10^{-4}	8.8×10^{-8}
Strontium-90	9.6×10^{-1}	1.1×10^{-4}	8×10^{-2}	1.0×10^{-5}
Antimony-125/ Tellurium-125m	2.0×10^{-2}	2.3×10^{-6}	2.0×10^{-3}	2.3×10^{-7}
Carbon-14	8.7×10^{-1}	1.0×10^{-4}	8.7×10^{-1}	1.0×10^{-4}
Technetium-99	8.7×10^{-3}	1.0×10^{-6}	8.7×10^{-3}	1.0×10^{-6}
Iron-55	4.2×10^{-3}	4.8×10^{-7}	4.2×10^{-3}	4.8×10^{-7}
Cobalt-60	4.2×10^{-3}	4.8×10^{-7}	4.2×10^{-3}	4.8×10^{-7}
Boron	150 tons H_3BO_3	3000 ppm B	150 tons H_3BO_3	3000 ppm B
Sodium	11 tons NaOH	700 ppm Na^+	nd	nd
Iodine-129	$<5.2 \times 10^{-3}$	$<6.0 \times 10^{-7}$	(d)	(d)
Cerium-144	$<1.4 \times 10^{-2}$	$<1.8 \times 10^{-6}$	$<1.4 \times 10^{-2}$	$<1.8 \times 10^{-6}$
Manganese-54	$<3.5 \times 10^{-4}$	$<4.0 \times 10^{-8}$	(d)	(d)
Cobalt-58	$<3.5 \times 10^{-4}$	$<4.0 \times 10^{-8}$	(d)	(d)
Nickel-63	$<5.2 \times 10^{-3}$	$<6.0 \times 10^{-7}$	(d)	(d)
Zinc-65	$<8.5 \times 10^{-4}$	$<9.8 \times 10^{-8}$	(d)	(d)
Ruthenium-106/ Rhodium-106	$<2.9 \times 10^{-3}$	$<3.3 \times 10^{-7}$	(d)	(d)
Silver-110m	$<4.9 \times 10^{-4}$	$<5.6 \times 10^{-8}$	(d)	(d)
Promethium-147	$<4.2 \times 10^{-2}$	$<4.8 \times 10^{-6}$	(d)	(d)
Europium-152	$<3.3 \times 10^{-6}$	$<3.8 \times 10^{-10}$	(d)	(d)
Europium-154	$<3.8 \times 10^{-4}$	$<4.4 \times 10^{-8}$	(d)	(d)
Europium-155	$<9.6 \times 10^{-4}$	$<1.1 \times 10^{-7}$	(d)	(d)
Uranium-234	$<8.7 \times 10^{-5}$	$<1.0 \times 10^{-8}$	(d)	(d)
Uranium-235	$<1.0 \times 10^{-4}$	$<1.2 \times 10^{-8}$	(d)	(d)
Uranium-238	$<1.0 \times 10^{-4}$	$<1.2 \times 10^{-8}$	(d)	(d)
Plutonium-238	$<1.0 \times 10^{-4}$	$<1.2 \times 10^{-8}$	(d)	(d)
Plutonium-239	$<1.2 \times 10^{-4}$	$<1.4 \times 10^{-8}$	(d)	(d)
Plutonium-240	$<1.2 \times 10^{-4}$	$<1.4 \times 10^{-8}$	(d)	(d)
Plutonium-241	$<5.7 \times 10^{-3}$	$<6.5 \times 10^{-7}$	(d)	(d)
Americium-241	$<1.0 \times 10^{-4}$	$<1.2 \times 10^{-8}$	(d)	(d)
Curium-242	$<8.7 \times 10^{-4}$	$<1.0 \times 10^{-7}$	(d)	(d)

(a) Letters and attachments from F. R. Standerfer (GPU Nuclear) to W. D. Travers (NRC) July 31, 1986, October 21, 1986, February 3, 1987, and February 18, 1987, and Appendix A, comment letter 14.

(b) Achievable with SDS/EPICOR II retreatment of all water. Base case includes retreatment of only the 40% that is currently in use.

(c) Concentrations were measured when the estimated water volume was 2.1 million gallons. This volume was assumed in calculating the quantity of tritium. Other measured concentrations were assumed to represent a removal efficiency, hence a volume of 2.3 million gallons was assumed.

(d) Some removal efficiency would be expected; however, because the radionuclide concentration is less than detectable before and after, no removal was assumed.

nd = not detectable.

< means less than. Values are listed at the analytical limit of detection. Impacts in this report have been estimated based on the assumption that these radionuclides are present at the listed values.

2.2 CHARACTERISTICS OF CONTAMINANTS IN THE ACCIDENT-GENERATED WATER

This section presents background information on the principal contaminants present and assumed to be present in the accident-generated water: tritium, cesium-137, strontium-90, carbon-14, iodine-129, boron, and sodium. The principal contaminants are those that have been identified as contributors to the potential environmental impacts estimated in this supplement. The environmental impact from radionuclides other than the principal ones was determined to be insignificant (i.e., less than 1%) relative to the principal radionuclides. Dose estimates presented in subsequent sections include the principal radionuclides, all others that have been detected, and those listed in Table 2.2 (assuming they are present at the listed detectable limit). Where possible, information on the normal environmental levels of these principal contaminants and their toxic effects are included.

Since the accident-generated water contains a mixture of radioactive materials, its radioactive properties can be described by its external radiation dose rate and by the internal dose equivalent that would be received following any ingestion and/or inhalation. External radiation from the contaminants in the water includes gamma rays principally from the decay of the cesium-137 daughter product and bremsstrahlung radiation from the beta-emitting radionuclides. The external dose rate to an individual standing 3 feet from a 3,800-gallon (14,000-liter) tank of accident-generated water (base case) has been calculated to be approximately 0.3 mrem/yr.[a] This is a very low dose rate relative to natural background in the Harrisburg area (approximately 87 mrem/yr).

As a means of characterizing the radiological hazard, the NRC staff has calculated the radiation dose that would result from consumption of 1 liter (1.06 quart) of accident-generated water (base case and achievable case) by an adult and by an infant. None of the evaluated alternatives would expose the public to the accident-generated water in this manner. The 50-year committed dose equivalent to an adult from consuming 1 liter (1.06 quart) of accident-generated water is 30 mrem. The dose drops to 10 mrem if the water is re-treated as discussed previously. For an infant, the 50-year dose commitment is 88 and 29 mrem, respectively. The doses to the bone[b] are somewhat higher, 960 and 87 mrem, respectively, for the adult, and 3100 and 280 mrem for the infant. This information is summarized in Table 2.3. These doses may be compared to an annual dose of approximately 87 mrem/yr from natural background radiation for Harrisburg, Pennsylvania.

For each principal contaminant, additional information is presented in three general categories: chemical and radiological characteristics,

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(a) Calculated using the computer code ISOSHLD II neglecting the shielding of the tank (Engel, Greenborg and Hendrickson 1966; Simmons et al. 1967).

(b) The bone is generally considered to be less sensitive to radiation effects than are other organs on which total body dose limits are based (ICRP 1959).

TABLE 2.3. Fifty-Year Dose Commitment from Ingestion of 1 Liter of Accident-Generated Water(a)

	Initial Accident-Generated Water		Achievable (100% Treated Water)	
	Total Body Dose, mrem	Organ Dose, mrem	Total Body Dose, mrem	Organ Dose, mrem
Adult				
Tritium (Hydrogen-3)	7.8	0	7.8	0
Carbon-14	0.057	0.28(b)	0.057	0.28(b)
Strontium-90	19	960(b)	1.8	87(b)
Cesium-137	2.6	3.0(b)	0.29	0.32(b)
Iodine-129	<0.0055	<4.3(c)	<0.0055	<4.3(c)
Total	30	960(b)	10	87(b)
Infant				
Tritium	23	0	23	0
Carbon-14	0.51	2.4(b)	0.51	2.4(b)
Strontium-90	63	3100(b)	5.7	280(b)
Cesium-137	1.6	19(b)	0.17	2.1(b)
Iodine-129	<0.0093	<8.2(c)	<0.0093	<8.2(c)
Total	88	3100(b)	29	280(b)

(a) All figures rounded to two significant digits.
(b) Bone is critical organ.
(c) Thyroid is critical organ.

interactions with biological systems, and environmental concentrations. Some of the important environmental characteristics of the contaminants are summarized in Table 2.4.

2.2.1 Tritium

The characteristics, interactions, and environmental concentrations of tritium are discussed in this section.

TABLE 2.4. Summary of Characteristics of Principal Contaminants in the Accident-Generated Water(a)

Contaminant	Half-Life, years	Decay Radiation	Background Concentration	Exposure Sources
Tritium (Hydrogen-3)	12.3	Beta	150 pCi/L in Susquehanna River	Water and plant and animal tissues
Cesium-137	30	Beta, gamma (daughter decay)	0.2 pCi/L in surface water	Fish, meat, and milk
Strontium-90	28	Beta (radioactive daughter also beta)	1 to 5 pCi/L in milk	Milk and other foodstuffs
Carbon-14	5,700	Beta	6.1 pCi/g carbon 10 to 8 pCi/L in water 2 to 68 pCi/g in grass	Carbohydrates and other foodstuffs
Iodine-129	15,700,000	Beta	(b)	(b)
Boron (present as the borate anion)	Nonradioactive		Normal human intake is 10 to 20 mg/day	Fruits and vegetables
Sodium ion	Nonradioactive		6 to 85 mg/L in fresh water supporting fish	Ubiquitous

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(a) References are given in the appropriate sections of the text.
(b) Measurements of iodine-129 in the environment are not routinely made.

2.2.1.1 Chemical and Radiological Characteristics of Tritium

Tritium (T) is an isotope of hydrogen with an atomic mass of 3. Tritium differs from hydrogen (atomic mass of 1) because it contains two addition neutrons in the nucleus. This isotope has a radiological half-life of 12.3 years and decays by beta emission to form nonradioactive helium (^3He). The tritium in the accident-generated water is in the chemical form of water with one of the nonradioactive hydrogen atoms replaced by a tritium atom; for this reason it cannot be removed by ion exchange. This compound is usually abbreviated HTO (hydrogen-tritium-oxygen or tritiated water) to differentiate it from ordinary water, H_2O.

The beta particle that is released by the decay of a tritium atom has a maximum energy of 18 keV and an average energy of 5.7 keV (NCRP 1979). Such particles have a range of 3 inches (7.6 centimeters) or less in air and a much shorter range in a denser medium such as water.

2.2.1.2 Interactions of Tritium with Biological Systems

The interaction of tritium with biological systems is, in part, a function of the chemical form of the compound. Tritium is generally assumed to be least hazardous as a gas (T_2), because hydrogen gas and T_2 usually do not interact with biological systems, and most hazardous as a tritiated organic compound. Organic molecules containing hydrogen or tritium may be incorporated into body tissue and reside for a longer time. Tritiated water is most likely intermediate in effect (ANSI 1983). Water and HTO interact but exchange rapidly, so residence time in the biological organism is short.

Tritium oxide (T_2O) and HTO behave in organisms much like ordinary water. The National Council on Radiation Protection and Measurement (NCRP) has concluded that "There is no evidence for a significant concentration process for tritium in either plants or animals" (NCRP 1979). The NCRP also states, "No apparent enrichment or concentration effect for tritium has been found in aquatic or terrestrial food chains. In fact, dilution in larger hydrogen or organic pools is the general rule,...." (NCRP 1979). Thus, while other radionuclides, including cesium and strontium, discussed in later sections, may concentrate in certain organisms in the food chain or certain portions of an organism, tritium does not.

When humans are exposed to tritium as tritiated water by inhalation, ingestion, or skin adsorption, the majority of the isotope is eliminated from the body with about a 10-day biological half-life. A small fraction of the intake, usually less than a few percent, is eliminated with a biological half-life of about 30 days, and even a smaller fraction with a biological half-life of about 450 days (NCRP 1979).

2.2.1.3 Environmental Concentrations of Tritium

Although tritium occurs naturally, its presence was only identified after the discovery of fission. Naturally occurring tritium is produced by cosmic-ray interactions with hydrogen, primarily in the upper atmosphere. The world inventory of tritium from processes other than manmade is estimated to be 70 million curies (MCi), which corresponds to a production rate of 4 MCi/yr (NCRP 1979).

Tritium is produced from fission and fusion; therefore, it occurs in all reactor fuel and in nuclear weapons tests. The world inventory of tritium resulting from weapons testing reached a maximum of about 3,100 MCi in 1963, and has been declining since (Combs and Doda 1979).

Tritiated water from the atmosphere is transferred to the surface of the earth mainly by precipitation, but also by vapor exchange (NCRP 1979). Tritium is formed in all water-cooled reactors, both in the primary coolant and in the fuel. The Final Supplement to the Final Environmental Statement Related to the Operation of TMI-2 (NRC 1976) predicted that operation of the plant would release 550 Ci/yr of tritium in liquid effluents and 560 Ci/yr in gaseous effluents. The total production rate in the U.S. in 1979 was estimated at 700,000 curies from reactors (Combs and Doda 1979).

Tritium is used in some consumer products, primarily luminous dial watches, instruments, and exit signs. In the fiscal year ending June 30, 1979, approximately 4,000,000 curies of tritium were distributed in digital watches and about 300,000 curies were distributed in other consumer products in the United States (Combs and Doda 1979). Although these are primarily sealed sources, the accidental destruction and ultimate disposal of these products contribute to the environmental tritium level.

The mean concentration of tritium in surface waters of the United States peaked at approximately 4,000 pCi/L in 1963 as a result of atmospheric weapons tests. By 1983 this concentration was less by about an order of magnitude. The background of naturally occurring tritium in surface waters is on the order of 100 pCi/L (Kathren 1984).

The tritium concentration of the Susquehanna River was measured during 1977 and found to be fairly constant at 178 pCi/L (NRC 1981). Beginning in 1979, following the accident, through 1985, the Commonwealth of Pennsylvania analyzed a total of 2,308 samples from the Susquehanna River and from water intakes which draw from the Susquehanna River, both upstream and downstream of the plant (Commonwealth of Pennsylvania 1981, 1982a, 1982b, 1983, 1984, 1985, and 1986). Of these samples, 2,307 contained less tritium than the lower limit of detection, which ranged from 230 to 440 pCi/L. A single sample taken at the Lancaster water intake showed 422 ± 192 pCi/L.

2.2.2 Cesium-137

The characteristics, interactions, and environmental concentrations of cesium-137 are discussed in this section.

2.2.2.1 Chemical and Radiological Characteristics of Cesium-137

Cesium-137 is one of 25 known isotopes of the element and is a product of the fission process. The naturally occurring isotope of the element is cesium-133. Chemically, all isotopes of cesium behave the same. Cesium, like sodium and potassium, is in the alkali metal group of the periodic table. It is very soluble in water and has a highly ionic nature in most chemical systems. The most notable exception to its water-soluble and ionic characteristics is its behavior relative to natural and synthetic zeolite compounds where it is strongly held in preference to all other elements. The cesium-zeolite affinity has facilitated the removal of cesium from the accident-generated water by the SDS. Cesium can also be removed by ordinary cation exchange resins.

Cesium-137 has a half-life of 30 years and decays to barium-137m, a radionuclide with a half-life of approximately 2.6 minutes. Barium-137m decays to barium-137, which is nonradioactive. The cesium decays by emission of two specific beta groups, one with a maximum beta energy of 1.176 MeV (7%) and the other with a maximum energy of 0.514 MeV (93%). The resulting barium-137m decays with the emission of a 0.66-MeV gamma ray. Cesium is usually spoken of as being a gamma emitter because the gamma emission from barium is always associated with it.

2.2.2.2 Interactions of Cesium-137 with Biological Systems

Five pathways of human exposure from environmentally distributed cesium-137 exist: 1) direct external radiation; 2) internal exposure from drinking contaminated water; 3) exposure from consumption of fish that live in contaminated water, especially bottom-feeding fish such as carp; 4) internal exposure from the consumption of milk from animals grazing on contaminated pasture; and 5) internal exposure from the meat of animals that grazed on contaminated pasture. Pasture may become contaminated by fallout or washout (from rain) from the air (Kathren 1984).

Cesium, in most commonly occurring compounds, is rapidly and almost completely absorbed from the gastrointestinal tract (ICRP 1979). The chemical behavior of cesium in the body is similar to potassium. The available evidence indicates that cesium is distributed uniformly in the body and therefore contributes to the total body dose. ICRP 30 indicates that the concentration of cesium in an organ or tissue will not be greater than the concentration in muscle (ICRP 1979). The typical daily intake of all isotopes of cesium is about 10 micrograms (μg) and the total body content of cesium is about 1.5 milligrams (ICRP 1979). The residence time in the body is relatively short with a biological half-life of about 140 days. Because of the type and energy of radiation emitted, and its uniform distribution, cesium and its decay products are considered to irradiate the total body.

2.2.2.3 Environmental Concentrations of Cesium-137

Nonradioactive cesium (cesium-133) makes up about 1 ppm of the earth's crust. Cesium-137, however, does not occur naturally but was primarily released to the environment by past weapons tests. Because of its 30-year radiological half-life, cesium-137 is relatively persistent in the environment. The concentrations of cesium-137 in the environment varies with location and with the frequency and occurrence of atmospheric testing of nuclear weapons. Concentrations in ocean surface waters are on the order of 0.2 pCi/L; concentrations are lower in deep waters by a factor of 30. On land most cesium-137 is contained in the top few centimeters of soil, with relatively little leaching (Kathren 1984). Cesium-137 concentration in fruits and vegetables range from 1 to 2 pCi/kg and approximately 10 times this amount in grain and dairy products.

The Commonwealth of Pennsylvania began performing isotopic analyses for cesium-134 and cesium-137 in Susquehanna River samples in 1981 (Commonwealth of Pennsylvania 1981, 1982a, 1982b, 1983, 1984, 1985, and 1986). Nine samples collected in December 1980 and August 1981 all contained less than the lower limit of detection, 15 pCi/L, of both isotopes. Samples collected in August 1981 through December 1985 have also all been below detectable limits, which ranged from 1 to 5 pCi/L.

2.2.3 Strontium-90

The characteristics, interactions, and environmental concentrations of strontium-90 are discussed in this section.

2.2.3.1 Chemical and Radiological Characteristics of Strontium-90

Strontium-90 is one of 18 known isotopes of the element strontium and is a product of the fission process. Natural strontium is a mixture of four nonradioactive isotopes, strontium-84, -86, -87, and -88. Strontium, like calcium, barium, and magnesium, is in the alkaline earth group of the periodic table and is metabolized by the body very much like calcium. It is readily soluble in water and can be removed by ordinary cation-exchange resins.

Strontium-90 is a pure beta-emitting radionuclide. It has a radiological half-life of approximately 28 years and decays to yttrium-90, which has a half-life of 64 hours. Yttrium-90 also decays by beta emission to nonradioactive zirconium-90. The maximum beta energy of strontium-90 decay is 540 keV, and the average is 195.8 keV. Decay of yttrium-90 has a maximum beta energy of 2.27 MeV and an average of 935 keV (Kathren 1984).

2.2.3.2 Interactions of Strontium-90 with Biological Systems

Strontium-90, as an analog of calcium, behaves in a similar manner in biological systems, concentrating in the bone of vertebrates and the shells of invertebrates. Strontium-90 also tends to concentrate in some marine biota, particularly algae (Kathren 1984). When it is deposited on land, strontium-90 is taken up by plants, and finds its way into the human food chain with the consumption of plants, grazing animals, milk, and drinking water (Kathren 1984). In humans, strontium-90 concentrates in bone and is secreted by lactating women.

The typical dietary intake of all isotopes of strontium in foods and fluids is about 1.9 milligrams per day and the total body content is about 0.32 grams (ICRP 1979). The residence time in the body is relatively long with a biological half-life of about 6,000 days. It is generally assumed to be uniformly distributed throughout the volume of mineral bone.

2.2.3.3 Environmental Concentrations of Strontium-90

The earth's crust averages about 300 ppm of natural strontium. Like tritium and cesium-137, strontium-90 is found in the environment primarily as a result of past weapons tests, but background levels of strontium-90 are rarely measured. [In September and December 1979, the Commonwealth of Pennsylvania analyzed a Susquehanna River sample taken at Columbia for strontium-89 and strontium-90. Both strontium-89 results were less than the detection limit of 17 pCi/L in September and 5 pCi/L in December. Both strontium-90 analyses were less than the detection limit of 2 pCi/L (Commonwealth of Pennsylvania 1981).] However, accurate data are available on strontium-90 concentrations in milk. The consumption of milk is the principal source of human exposure to this radioisotope. The U.S. Public Health Service collected data for the years 1958 to 1972, the time period during which most of the atmospheric weapons tests were conducted. Measured concentrations of strontium-90 ranged from a low of 1 pCi/L to a high of 31 pCi/L. By 1972, the average concentration in the milk in 9 cities was 4.9 pCi/L (NCRP 1975a). This approximate level was maintained on the east coast of the United States (New York) through the 1970s, but decreased by 1980. Levels of strontium-90 in 11 milk samples taken in Pennsylvania in May and June 1986 ranged from 1 to 5 pCi/L (EPA 1986). Levels of average strontium-90 intake on the west coast (San Francisco) were about one fourth of the levels found on the east coast. Typical dietary intake for New York adults was approximately 5 pCi/L in 1980 (Klusek 1981).

For 1970 and beyond, the average annual intake was estimated at 1,800 pCi/yr for an infant, 4,600 pCi/yr for persons aged 2 to 20 years, and 3,570 pCi/yr for persons over 20 years old (Klement et al. 1972). Annual bone dose from these intakes are estimated to vary from a low of 2.2 mrem/yr for the infant to a high of 41.9 mrem/yr for the adult (Klement et al. 1972). The total body dose from strontium-90 is approximately one-tenth of the bone dose (Klement et al. 1972). The bone dose is higher because more of the strontium-90 concentrates in the bone than in the rest of the body.

2.2.4 Carbon-14

The characteristics, interactions, and environmental concentrations of carbon-14 are discussed in this section.

2.2.4.1 Chemical and Radiological Characteristics of Carbon-14

Carbon-14 is one of seven isotopes of carbon. Carbon is widely distributed in nature, approximately 320 ppm in the earth's crust and approximately 30 ppm in seawater, and forms a large number of compounds. There are a million or more known compounds of carbon, many thousands of which are vital to organic and life processes. The majority of carbon is inorganic in the form of the bicarbonate (HCO_3^-) ion. Virtually all the carbon in the atmosphere is in the form of CO_2, which may react with plant life and be incorporated in organic material. The most likely form of carbon in the accident-generated water is an inorganic bicarbonate. Nonradioactive carbon, greater than 99.9% of all carbon, has two isotopes, carbon-12 and carbon-13. Carbon-14, the most abundant of the radioactive carbon isotopes, is produced naturally by cosmic ray interactions in the atmosphere. It is also a product of the detonation of thermonuclear devices and of nuclear reactor operations (NCRP 1985).

Carbon-14 is a pure beta-emitting radionuclide. It has a half-life of 5,730 years and decays to nonradioactive nitrogen-14. Its beta particle has a maximum energy of 0.156 MeV and an average energy of 0.045 MeV (NCRP 1985).

2.2.4.2 Interactions of Carbon-14 with Biological Systems

The metabolism of carbon-14 in the human body follows that of ordinary carbon. A fraction of carbon introduced into the body is retained as protein, fat, carbohydrates, and other materials. The biokinetics of carbon are extremely complicated with body retention and excretion rates depending on age and metabolism and the tissue under consideration. The ICRP suggests a biological half-life of 40 days as a conservative value (NCRP 1985). Of the 70-kg mass of reference man, approximately 16 kg (22.9%) is carbon, of which much less than 0.1% is carbon-14.

2.2.4.3 Environmental Concentrations of Carbon-14

Carbon-14 is formed naturally in the upper atmosphere by the reaction of neutrons of cosmic-ray origin with nitrogen and, to a lesser extent, with oxygen and carbon. About 38,000 curies of carbon-14 are produced annually this way. The current atmospheric inventory of carbon-14, principally from natural production and thermonuclear device detonations, is estimated at 13,400,000 curies (NCRP 1985). The worldwide inventory of natural carbon-14 is about 310,000,000 curies, of which more than 95% is in the oceans, ocean sediments, and soil (Kathren 1984). The assumed specific activity of natural carbon-14 in the terrestrial biosphere is 6.1 pCi per gram of carbon (NCRP 1975a). The dose to humans from carbon-14 in the environment is about 1.7 mrem per year with the majority of the dose being to fatty tissue.

Significant geographic variations in carbon-14 concentrations can be expected because of thermonuclear detonation fallout patterns, operating nuclear power plant locations, and other contributions.

2.2.5 Iodine-129

The characteristics, interactions, and environmental concentrations of iodine-129 are discussed in this section.

2.2.5.1 Chemical and Radiological Characteristics of Iodine-129

Iodine-129 is the longest-lived radioisotope of iodine with a half-life of 1.57×10^7 years. Iodine-129 is both natural and manmade, being produced by fission reactions and by cosmic reactions in the upper atmosphere. One isotope of iodine, iodine-127, is nonradioactive. The remaining 22 known isotopes of iodine, including most iodine-129, are artificially produced, primarily by fission reactions. Relatively large quantities of radioactive isotopes of iodine are produced in reactor fuel during the fission process. These isotopes, with the exception of iodine-129, have short half-lives, on the order of minutes and days (maximum of 60.14 days). Consequently, after a relatively short period of time, iodine-129 with its 15.7 million year half-life is the only radioactive isotope of iodine remaining. Fortunately, the yield of this nuclide from the fission reaction is so low that it is of little consequence (Kathren 1984). Iodine is of the halogen family and occurs sparingly in the form of iodides in seawater. It forms compounds with many elements, but is less active than most other halogens. The most common compounds are the iodides of sodium and potassium, but iodine may also be present as hypoiodious acid (HIO), hydriodic acid (HI), iodic acid (HIO_3), and metal iodides.

Iodine-129 emits beta radiation with a maximum energy of 0.150 MeV and an average energy of 0.0488 MeV. It decays to xenon-129, which is chemically inert and radiologically stable.

2.2.5.2 Interactions of Iodine-129 with Biological Systems

Iodine, taken into the body by ingestion or inhalation, is readily absorbed into the blood and is preferentially deposited in the thyroid gland. The size of the thyroid gland and its uptake of iodine from the blood both depend on the daily intake of nonradioactive iodine (ICRP 1979). Consequently, the uptake of iodine-129 is also dependent on the availability of other iodine to the body. Of iodine taken into the body, about 30% is assumed to be translocated to the thyroid while the remainder is excreted. Iodine in the thyroid has a biological half-life of about 120 days. Some small fraction of the iodine leaving the thyroid will be deposited uniformly among all organs and tissues of the body and retained with a half-life of about 12 days (ICRP 1979). Radioiodines are used extensively as tracers by the medical profession to determine metabolic activity of the thyroid. Nonradioactive iodine is also used for a variety of other medicinal purposes. Lack of iodine is the usual cause of goiter in humans.

2.2.5.3 Environmental Concentrations of Iodine-129

Since iodine-129 is a naturally occurring radionuclide and has a very long half-life, some fraction of all iodine is iodine-129. The worldwide inventory of iodine-129 is increasing because of nuclear testing and nuclear reactor operation. Thus, the ratios of iodine-129 atoms to iodine-127 atoms in the environment are also increasing. Analyses of pre-1945 material (including nitrates, reagents, and animal and human thyroids) showed these ratios to range from 0.002×10^{-9} to 2.5×10^{-9}. Analyses of bovine thyroid tissue collected throughout the United States from 1964 to 1969, excluding areas with known significant contributors,[a] showed an average ratio of 23.7×10^{-9}. Iodine-129 concentrations in water and grass from areas in the northwestern United States showed 10 to 80×10^{-6} pCi/L in the water and 2 to 68×10^{-6} pCi/g in the grass (Brauer 1973). Concentrations of iodine-129 and resulting doses are so low that it is not considered in most evaluations of environmental radiation. Estimated thyroid doses, even in areas of the United States with the highest concentrations, are less than 0.5 mrem per year. Because of its extremely low specific activity, iodine-129 is not of particular environmental significance (Kathren 1984).

(a) Areas excluded were Georgia, North Carolina, northeastern Oregon, South Carolina, Tennessee, and eastern Washington.

2.2.6 Boron

The characteristics, interactions, and environmental concentration of boron are discussed in this section.

2.2.6.1 Chemical Characteristics of Boron

The element boron is not found free in nature but occurs as orthoboric acid and as borates. Natural boron is a mixture of two isotopes, boron-10 and boron-11, neither of which is radioactive. Boron readily combines with other elements to form compounds. Boron compounds are generally readily soluble in water. Boron, in the form of boric acid, is a weak acid with the chemical formula H_3BO_3 (orthoboric acid). Some of the boric acid in the accident-generated water has been converted to sodium borate by the addition of sodium hydroxide to adjust the pH in the reactor coolant. Sodium salts of boron tend to adsorb and hold water from air and are therefore difficult to dry completely. Boric acid and sodium borate are not radioactive but are used in nuclear processes for their neutron-absorption properties. Retreatment of the accident-generated water to obtain the achievable quantity and concentration shown in Table 2.2 would remove the sodium ion and reconvert the borate to boric acid. The borate anion in the accident-generated water is difficult to remove by ion exchange because it is loosely held by anion exchange resins and is present in such high concentrations.

Neither boric acid nor its salts are considered to be a hazardous chemical under the U.S. Environmental Protection Agency's (EPA) hazardous waste rules (40 CFR Part 261, Appendix VIII). Boron discharges into receiving water are regulated by the state which issues the National Pollutant Discharge Elimination System (NPDES) permit.

2.2.6.2 Interactions of Boron with Biological Systems

Boron is essential to the nutrition of higher plants. However, there is no evidence that it performs any vital function in human or animal nutrition (McKee and Wolf 1963). Plant roots take up small quantities of dissolved borates from the soil solution; the absorbed boron is moved to the leaves where it tends to accumulate in the tip and margin of leaves (McKee and Wolf 1963).

Boron concentrations of 1 to 4 ppm in irrigation water impair plant growth. The degree of impairment from boron depends upon the plant species. None of the alternatives considered would involve direct application of the accident water to plants except incidentally, in a highly diluted form at levels below that which would affect plant growth. For example, boron discharged to the river would be taken up by downstream water users who may use it to irrigate yards and plants. However, accidental application by spills or tank ruptures is a possibility and is discussed in Section 3. Plant growth would be inhibited in the immediate vicinity of the spill until the boron is removed either by cleanup or dispersion by wind and/or water. Once boron levels in soil water are below 1 ppm, normal vegetative growth would be expected.

People consume 10 to 20 mg of boron per day primarily by eating fruits and vegetables, which contribute the most boron to the human diet, and by drinking water. Boron in food or water is rapidly and completely absorbed by the human system but it is also promptly excreted in the urine (McKee and Wolf 1963).

The ingestion of excessive amounts of boron may cause nausea, cramps, convulsions, coma, and other symptoms of distress. The fatal dose for adults has been reported from 5 to 45 grams. Reportedly, normal adults have been fed 3 grams of boric acid per day for 11 to 16 days without apparent toxic effects (McKee and Wolf 1963).

Small amounts of boron in drinking water are not generally regarded as a hazard to humans. Boron concentrations up to 30 mg/L are reportedly not harmful in drinking water. Above this concentration, boron may interfere with digestion because of its preservative action on foods. "Quantities up to 0.5 grams per day of either borax or boric acid have no immediate effect of any kind on healthy individuals" (McKee and Wolf 1963).

The lethal dose of boric acid for animals varies from 1.2 to 3.45 grams of boric acid per kilogram of body weight, depending on the species. Concentrations of 2,500 mg/L of boric acid in drinking water have been detrimental to animals, inhibiting growth. Synthetic borates have been found to be far more toxic to animals than natural boron compounds such as boric acid and sodium borate.

Boric acid in high concentrations is mildly toxic to fish. Wallen, Greer and Lasater (1957) found that a concentration of 5,600 mg/L of boric acid was necessary to kill 50% of mosquito-fish exposed to this solution for 96 hours.

2.2.6.3 Environmental Concentrations of Boron

The average amount of boron in the earth's crust is 3 ppm (Weast 1983). Deposits of boron compounds such as borax, colemanite, and rasorite, are mined to supply industrial needs. Boron occurs naturally in the minerals sassolite (boric acid), borax (sodium borate), and colemanite (calcium borate) (Windholz et al. 1976; McKee and Wolf 1963). Boric acid and boron salts are used extensively in consumer products as a mild antiseptic (boric acid) and as a water softener in washing powders (borates) as well as in industry for weatherproofing wood, fireproofing fabrics, manufacturing glass and porcelain, and producing such products as leather, carpets, cosmetics, photographs, and artificial gems. Boron hydrides or borates are used in high-energy petrochemical fuels. Boron is also used in metallurgy to harden metals (McKee and Wolf 1963).

At TMI, boron has been used as a neutron absorber to prevent inadvertent criticalities in the RCS and fuel storage pools and in areas where precise estimates of the quantity of fuel debris are unavailable.

2.2.7 Sodium

Sodium is a principal element in the compound sodium hydroxide (NaOH). Sodium hydroxide, a highly basic (caustic) compound, is present in dissolved form in the accident-generated water because it was used to adjust the pH of the water when boric acid was added. The chemical characteristics, interactions, and environmental concentration of the sodium ion are discussed in this section.

2.2.7.1 Chemical Characteristics of Sodium

Sodium, an element of the alkali metal group of the periodic table, is not found free in nature. Sodium-23 is the naturally occurring isotope of the element and it is not radioactive.

Most chemical and biological properties of sodium hydroxide that are reported in the literature result from its highly caustic property and are not applicable to the accident-generated water, which has a near-neutral pH. The constituent of interest in the accident-generated water is the sodium ion. Sodium is extremely soluble in water and in body fluids. The sodium ion is common in many chemical compounds including table salt. Essential to all forms of plant and animal life, sodium is not considered toxic or harmful except when present in excess. For example, those people with high blood pressure are often cautioned to limit their sodium intake.

2.2.7.2 Interactions of the Sodium with Biological Systems

Sodium is one of the seven major minerals present in the body as ions that play important roles in the electrical properties of cells and in the transfer and utilization of chemical energy (Vander, Sherman and Luciano 1980). Sodium is vital to the osmotic balance between cells and body fluids. It is readily absorbed by the body and as readily excreted depending on body needs. The sodium ion constitutes far less than 1% of the total atoms of the body. Normal sodium intake is about 10.5 g/day but may vary from 50 milligrams for a patient on a low-salt diet to 25 grams for a gross consumer (Vander, Sherman and Luciano 1980).

2.2.7.3 Environmental Concentration of Sodium

Sodium is the sixth most abundant element on earth, comprising about 2.8% of the earth's crust. Its most common compound is sodium chloride, which is used extensively in food and food products.

Sodium in relatively high concentration is detrimental to fresh water fish and other aquatic life. Extremely low concentrations are also detrimental. About 95% of the waters supporting a good fish fauna have less than 85 mg/L sodium plus potassium. About 50% have less than 10 mg/L sodium plus potassium and only 5% have less than 6 mg/L sodium plus potassium (McKee and Wolf 1963). Water sampling in the Susquehanna River between June 1967 and August 1974 showed minimum, average, and maximum sodium concentrations of 2.3, 12.71, and 52.9 mg/L, respectively (NRC 1976).

2.3 REGULATORY AND ADMINISTRATIVE CONSIDERATIONS

Disposition of the accident-generated water must be carried out in accordance with all applicable federal and state laws, regulations, and permits as discussed below.

2.3.1 U.S. Environmental Protection Agency Regulations

The EPA has the responsibility and authority to set standards for the release of radionuclides to the environment to protect the public from radioactivity. The EPA also has the authority to regulate the handling, storage, and disposal of hazardous nonradioactive materials. These authorities arise from various federal laws and executive orders including the Atomic Energy Act, the Clean Water Act, the Safe Drinking Water Act, the Resource Conservation and Recovery Act (RCRA), and the Clean Air Act.

Any release of radioactivity (to the atmosphere or to any water body) must meet EPA's environmental standards for the uranium fuel cycle in 40 CFR 190, which require that "The annual dose equivalent does not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ of the body as the result of exposures to planned discharges of radioactive materials, radon and its daughters excepted, to the general environment from uranium fuel cycle operations and to radiation from these operations."

Any release of radioactivity to waters of the United States, including the Susquehanna River must meet EPA's National Interim Primary Drinking Water Standards in 40 CFR 141 that limit beta particle and photon radioactivity from manmade radionuclides in community water systems to that level which "... shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year." The regulation specifically calculates 2 L/day of water consumption and states that 20,000 pCi/L tritium or 8 pCi/L strontium-90 are assumed to produce the annual total body or organ limit of 4 mrem/yr. This standard applies to concentrations at community water intakes downstream of the discharge point.

Wastes from disposal of the accident-generated water under any disposal method contemplated would not meet the definition of "hazardous waste" under RCRA. Hence, EPA regulations in 40 CFR 260-271 would not apply.

The EPA also has the responsibility of regulating ocean disposal of radioactive wastes for the United States, but has not yet established allowable conditions for ocean disposal. See also Section 3.6.1.

2.3.2 U.S. Nuclear Regulatory Commission Regulations

The NRC regulations in 10 CFR 20, "Standards for Protection Against Radiation," apply to the disposal of the accident-generated water. These regulations implement the EPA standards in 40 CFR 190 and specify allowable discharge concentrations of radioactivity in effluents to air and water in unrestricted areas. Maximum permissible concentrations (MPC) of tritium, strontium-90, cesium-137, carbon-14, and iodine-129 are presented in Table 2.5.

TABLE 2.5. Maximum Permissible Concentrations in Air and Water Above Background in Unrestricted Areas (µCi/mL)[a]

Isotope[b]		Air	Water
Tritium (Hydrogen-3)	S	2×10^{-7}	3×10^{-3}
	I	2×10^{-7}	3×10^{-3}
	Sub	4×10^{-5}	......
Cesium-137	S	2×10^{-9}	2×10^{-5}
	I	5×10^{-10}	4×10^{-5}
Strontium-90	S	3×10^{-11}	3×10^{-7}
	I	2×10^{-10}	4×10^{-5}
Carbon-14	S	1×10^{-7}	8×10^{-4}
	Sub[c]	1×10^{-6}	......
Iodine-129	S	2×10^{-11}	6×10^{-8}
	I	2×10^{-9}	2×10^{-4}

(a) When more than one radionuclide is present, the sum of the concentrations of each radionuclide, divided by the concentration in the table, must be less than or equal to 1 (10 CFR 20 App B footnote 1).

(b) S = soluble
I = insoluble
Sub = submersion in a semispherical infinite cloud of airborne material.

(c) As carbon dioxide, CO_2.

Nuclear Regulatory Commission regulations in 10 CFR 71, "Packaging and Transportation of Radioactive Materials," apply to the packaging and shipment of low-level radioactive wastes resulting from some alternatives for disposal of the accident-generated water. If the radionuclide concentrations in the product waste forms are such that the wastes would be required to be transported in accident-resistant Type B shipping containers, special provisions apply. This regulation is interpreted to apply to resins used for retreatment in some alternatives. Because only small amounts of radioactive material are present in the accident-generated water, it is anticipated that the radionuclide concentrations in the non-resin wastes generated in all alternatives will be such that a less durable Type A shipping container can be used. The standards for Type A shipping containers, which are designed to withstand tests that simulate extreme conditions of normal transport, are found in Department of Transportation (DOT) regulations in 49 CFR 173. These DOT regulations in 49 CFR 171 to 179 are applicable to the packaging and shipment of the product waste forms produced in each alternative.

Nuclear Regulatory Commission regulations in 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," will apply to the disposal of any residues from the accident-generated water in a licensed low-level waste (LLW) burial site. While these regulations pertain to the licensing, operation, and closing of a low-level commercial waste burial ground, they also contain specifications for the packaging, content, and characteristics of acceptable LLWs. Low-level radioactive wastes are classified as Class A, B, C, or unacceptable, depending on radioactive material content and concentration and on characteristics other than radioactivity. For example, liquid wastes must be solidified.

Under NRC regulations, nuclear power plant licensees must dispose of solid waste containing any licensee-generated contamination at commercial waste disposal sites. Other dispositions may be approved on a case-by-case basis under the provisions of 10 CFR 20.302. Under 10 CFR 20.302 nuclear power plant licensees may apply for disposal of slightly contaminated radioactive materials at other than commercial waste sites (e.g., commercial landfill or onsite). Nuclear Regulatory Commission staff consideration of requests for onsite disposal of slightly contaminated radioactive material has focused principally on demonstrating that potential doses are a small fraction of annual background radiation exposure.

For disposal of radioactive materials in NRC non-Agreement States, the licensee's application is reviewed solely by the NRC. For disposal of radioactive materials in an NRC Agreement State, the NRC staff grants approval only for handling and storage. The Agreement State has jurisdiction for disposal either inside or outside of the site exclusion area. The Commonwealth of Pennsylvania is currently a non-Agreement State but may become an Agreement State in the future.

The NRC regulates the storage of LLW at licensee sites. Because of the perturbations brought about by the provisions of the Low Level Waste Policy Act and its amendments (see Section 2.3.3 for a discussion of these acts), many sites have made provisions for storing LLW for periods beyond that normally required by operational considerations. The NRC has permitted this within carefully controlled limits, but has clarified its policy in Generic Letter 85-14,(a) which states: "It is the policy of the NRC that licensees should continue to ship waste for disposal at existing sites to the maximum extent practicable."

2.3.3 Low-Level Radioactive Waste Policy Amendments Act of 1985

The Low-Level Radioactive Waste Policy Amendments Act of 1985 could have a significant impact on the alternative selected for disposing of the accident-generated water. The following provisions of the Act, H.R. 1083 - Public Law 99-240, may be applicable:

- Each commercial nuclear power reactor shall, upon request, receive an allocation of low-level radioactive waste disposal capacity at one of the three existing regional disposal facilities. This capacity, in cubic feet, for the transition period of January 1, 1986, through December 31, 1989, is determined for pressurized water reactors (PWRs) by multiplying the number of months remaining in the period by 871, and by 1951 for boiling water reactors (BWRs). For the licensing period of January 1, 1990, through December 31, 1992, it is determined by multiplying the number of months remaining in the period by 685 for PWRs (1533 for BWRs). The number of months shall be computed beginning with the first month of the applicable period.

(a) A letter to all licensees from the U.S. Nuclear Regulatory Commission, August 1, 1985, Subject: Commercial Storage at Power Reactor Sites of Low-Level Radioactive Waste Not Generated by the Utility.

- Any unused allocation received by a reactor during the transition period may be used at any time prior to December 31, 1992, or prior to the commencement of operation of a regional disposal facility in the compact region or state in which the reactor is located, whichever occurs first.

- A commercial nuclear power reactor in a state or compact region that meets the requirements for access to a regional disposal facility may assign any disposal capacity allocated to it to any other person in the state or compact region.

- The Secretary of Energy may, upon petition by the owner or operator of a commercial nuclear power reactor, allocate to the reactor, disposal capacity in excess of the amount calculated above to permit unusual or unexpected activities, providing these excess allocations, in total, do not result in the acceptance for disposal of more than 800,000 ft^3 (22,700 m^3) of low-level radioactive waste or a total of the allocations in excess of 11,900,000 ft^3 (337,000 m^3) for the 7-year period of 1986 through 1992.

- The disposal of low-level radioactive waste (other than low-level radioactive waste generated in a sited compact region) may be charged a surcharge by the state in which the applicable regional disposal facility is located. Surcharges shall not exceed $10 per cubic foot in 1986 and 1987, $20 per cubic foot in 1988 and 1989, and $40 per cubic foot in 1990 and 1991.

In parallel with its proposal to the NRC to evaporate the accident-generated water and to solidify the evaporator bottoms for disposal at a commercial disposal site, the licensee has petitioned the Secretary of Energy for additional waste volume allocation. The DOE has approved the licensee's request contingent upon an analysis by GPU that demonstrates that low-level waste will exceed the basic allocation.

2.3.4 Permits

The licensee holds an NPDES permit issued by Commonwealth of Pennsylvania, Department of Environmental Resources (PaDER). A new permit was issued September 16, 1986 and covers discharge of nonradioactive pollutants into the Susquehanna River. Any deliberate discharge of the accident-generated water into the Susquehanna River must comply with the provisions of the permit. The NPDES permit limits pH, free chlorine, and heat, and requires monitoring of several other parameters at the primary outfall and other quantities at other outfalls. Limits are not specified for sodium or boron; however, the permit does specify "The controlled rate of batch discharges of waste water containing total boron shall be approved by the Department in a letter amendment prior to discharge" (p. 14A of 14).

2.3.5 U.S. Nuclear Regulatory Commission Policy

Following publication of the final PEIS in 1981, the Commission issued a policy statement stating that, "Any future proposal for disposition of processed accident-generated water shall be referred to the Commission for approval" (Statement of Policy 1981). This means that the Commission itself will make the final decision on disposal of the accident-generated water. The TMI-2 license currently prohibits disposal of the accident-generated water; however, a license amendment has been requested by the licensee.(a)

2.3.6 U.S. Department of Energy

The U.S. Department of Energy is not a regulatory body, but has been chartered by Congress to make emergency allocations of radioactive waste burial space, as discussed in Section 2.3.3. The DOE has conditionally approved a special allocation to the licensee in a letter.(b)

Shortly following the TMI-2 accident, DOE agreed to accept, without cost, waste from TMI-2 that would be valuable in their research programs. They also agreed to accept, on a cost reimbursement basis, abnormal waste that could not be disposed of at currently licensed waste disposal sites. It is under this agreement, documented in the Memorandum of Understanding, that the damaged fuel from TMI-2 is being accepted by the DOE.

The Memorandum of Understanding does not cover waste that can be disposed of by other means. All the waste streams in all the alternatives would be materials that could be disposed of in commercial burial sites; hence, participation by the DOE in disposal under any alternative would require a new agreement.

(a) Technical Specification Change Request No. 56 to the U.S. Nuclear Regulatory Commission from F. R. Standerfer, Director, TMI-2, GPU Nuclear, February 25, 1987. Technical Specification Change Request No. 56-Revised to the U.S. Nuclear Regulatory Commission from F. R. Standerfer, Director, TMI-2, GPU Nuclear, April 13, 1987.

(b) Letter to E. E. Kintner, Executive Vice President, GPU Nuclear, from James W. Vaughan, Jr., Principal Deputy Assistant Secretary for Nuclear Energy, U.S. Department of Energy, February 11, 1987.

3.0 PROPOSED AND ALTERNATIVE PLANS FOR ACCIDENT-GENERATED WATER DISPOSAL

The licensee's proposed method of accident-generated water disposal and NRC staff-identified alternatives are evaluated in this section. Although the list of alternatives is extensive, as a practical matter, not all possible alternatives are covered. The alternatives that are discussed include those that the NRC identified as having the highest potential for technical feasibility and regulatory acceptability.

The alternatives are divided into two general categories: alternatives that were quantitatively evaluated, and alternatives that were considered but rejected. Each of the 9 alternatives shown in Table 3.1 was evaluated, and is described in Sections 3.1 through 3.5. The alternatives are organized so that similar alternatives are considered in the same subsections. The alternatives are organized into five groups: onsite evaporation, bulk liquid shipment, direct solidification, river discharge, and onsite storage. An additional 15 alternatives were considered and rejected because they were unlikely to gain regulatory acceptance, technically infeasible, or clearly inferior to other alternatives of comparable or lesser cost. Each of the rejected alternatives are discussed briefly in Section 3.6.

The discussion of the evaluated alternatives includes the following topics: the system and operations that would be required to implement the alternative; the estimated environmental impacts; analysis of potential accidents; and regulatory constraints.

The principal non-accident environmental impacts associated with planned disposition of the accident-generated water are occupational radiation dose, radiation dose to the maximally exposed member of the general public, population dose, and resources committed (waste burial ground volume, land area, and financial resources in 1986 dollars, excluding the cost of any regulatory delays). The bases for offsite dose estimates are documented in Appendix C. The environmental impact of possible accidents includes the results of accidents occurring onsite and offsite. Possible onsite accidents are primarily liquid spills. Possible offsite accidents are primarily transportation accidents. Appendix D describes the basis for transportation accident estimates. Radiation doses from transportation of the accident-generated water or its residues are considered negligible and are therefore not presented (see Section C.2).

The radiological and nonradiological impacts to aquatic and terrestrial organisms have been determined to be insignificant and are not discussed further. With regard to radiological impacts, it is generally agreed that the limits established for humans are sufficiently protective for other species. Specifically, the 1972 report of the National Academy of Sciences (NAS) Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR 1972) concluded that no other living organisms are very much more radiosensitive than humans. Additionally, no significant nonradiological impacts to aquatic or terrestrial organisms are expected to result from any alternative because of the small quantity and characteristics of nonradiological contaminants in the accident-generated water.

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TABLE 3.1. Summary of the Alternatives Evaluated

Section and Title		Retreatment[a]	Disposition of Tritium	Disposition of Borate[b]
3.1.1	Evaporation, Solidification of Bottoms, and Disposal at a Licensed Burial Ground	No	Atmosphere at TMI	LLW burial ground[c]
3.1.2	Evaporation, Solidification of Bottoms, and Retention Onsite	Yes	Atmosphere at TMI	TMI Site
3.1.3	Distillation, Solidification, and Disposal of Bottoms Followed by River Discharge	No	Susquehanna River	LLW burial ground[c]
3.2.1	Offsite Evaporation at the NTS[d]	No	Atmosphere at NTS[d]	Shallow land burial at NTS[d]
3.3.1	Permanent Onsite Storage of Solidified Waste	Yes	Atmosphere at TMI	Ground at TMI Site
3.3.2	Solidification and Disposal at a Commercial Low-Level Waste Site	No	Atmosphere at TMI	LLW burial ground[c]
3.4.1	Long-Term River Discharge	Yes	Susquehanna River	Susquehanna River
3.4.2	Short-Term River Discharge	Yes	Susquehanna River	Susquehanna River
3.5.1	Liquid Storage in Tanks (no-action alternative)	No	TMI	TMI Site

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(a) Retreatment of the accident-generated water would involve processing all of the water including that currently in storage, with the SDS and EPICOR II system. Retreated water would have the "achievable" concentrations and quantities shown in Table 2.2. Water that is not retreated is represented by the base case.

(b) In every case there would be some cesium-137, strontium-90, and carbon-14 associated with the borate; however, in those options employing retreatment of the water, the quantity is approximately 1/10 of what it is without retreatment.

(c) A commercial NRC-licensed site for low-level radioactive waste disposal. The site operated by U.S. Ecology near Richland, Washington is assumed.

(d) NTS = Nevada Test Site, a DOE facility.

The impacts of each alternative and the relationship between radiation dose and potential health effects are discussed in Section 5.0.

3.1 ALTERNATIVES INVOLVING ONSITE EVAPORATION

The licensee's proposal and two alternatives involving onsite evaporation are evaluated. All involve the use of a commercial low-level liquid waste evaporator, and differ only in the disposition of the evaporator bottoms and evaporator effluent. Four additional onsite evaporation alternatives were considered but were rejected and are discussed in Sections 3.6.2, 3.6.3, 3.6.4, and 3.6.5.

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3.1.1 Evaporation, Solidification of Bottoms, and Disposal at a Licensed Burial Ground

This method of disposal, proposed by the licensee, involves forced evaporation into the atmosphere of the majority of the accident-generated water in a commercially available system. Forced evaporation of the accident-generated water would release most of the tritium to the atmosphere and concentrate the remaining radioactivity and chemical contaminants in a liquid residue (evaporator bottoms).[a] A volume-reduction factor of at least 10 to 20 is expected. Portland cement would be mixed with the residue and the slurry poured into containers for solidification. The solid waste would then be transported to the commercial (NRC-licensed) LLW burial site.

3.1.1.1 System Description and Operation

A modular, commercially available evaporation system would be installed on a concrete pad at the site. Piping from existing water storage locations would be connected to the evaporator system. A possible location is shown on the site plan in Figure 3.1. The accident-generated water, without additional treatment (base case), would be fed to the evaporator where it would be heated and evaporated. Although most vendor-supplied evaporator systems are designed to operate in a closed-cycle mode, modifications would be made to the evaporator to allow it to operate in an open-cycle mode that would permit vapor to be discharged to the atmosphere. Some form of moisture separator and/or vapor superheater would be provided to assure that liquid droplets and dissolved components are not discharged with the vapor. Discharge of the vapor would be through a 100-ft (30-m) stack constructed for this purpose. In addition to analyses of the evaporator feed, the discharge would be monitored to verify radioactivity release rates.

In its initial proposal, the licensee assumed a typical processing rate of 3 gal/min (11.4 L/min) and operating enough of the time to complete evaporation and solidification in approximately 28 months. A total of about 33 months would be required for setup, processing, and decommissioning of the equipment. Based on additional information provided by the licensee (Appendix A comment letter 14), the feed rate may be increased up to 20 gal/min in order to decrease the operating time to as little as 4 months. Setup and takedown time would still be approximately 5 months.

The resultant evaporator bottoms would be mixed with Portland cement in large, approximately 170-ft^3 (4.8-m^3) liners for forming, curing, transporting, and burial. The total solidified volume is expected to be between 27,000 and 46,000 ft^3 (765 to 1,300 m^3), for 25 wt% solids and 16 wt% solids, respectively, assuming a 0.35 cement binder-to-bottoms volume ratio as shown in Table 3.2.

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[a] The terms "evaporator bottoms" and "residue" are used to refer to the concentrated salts that are left after the majority of the accident-generated water has been evaporated.

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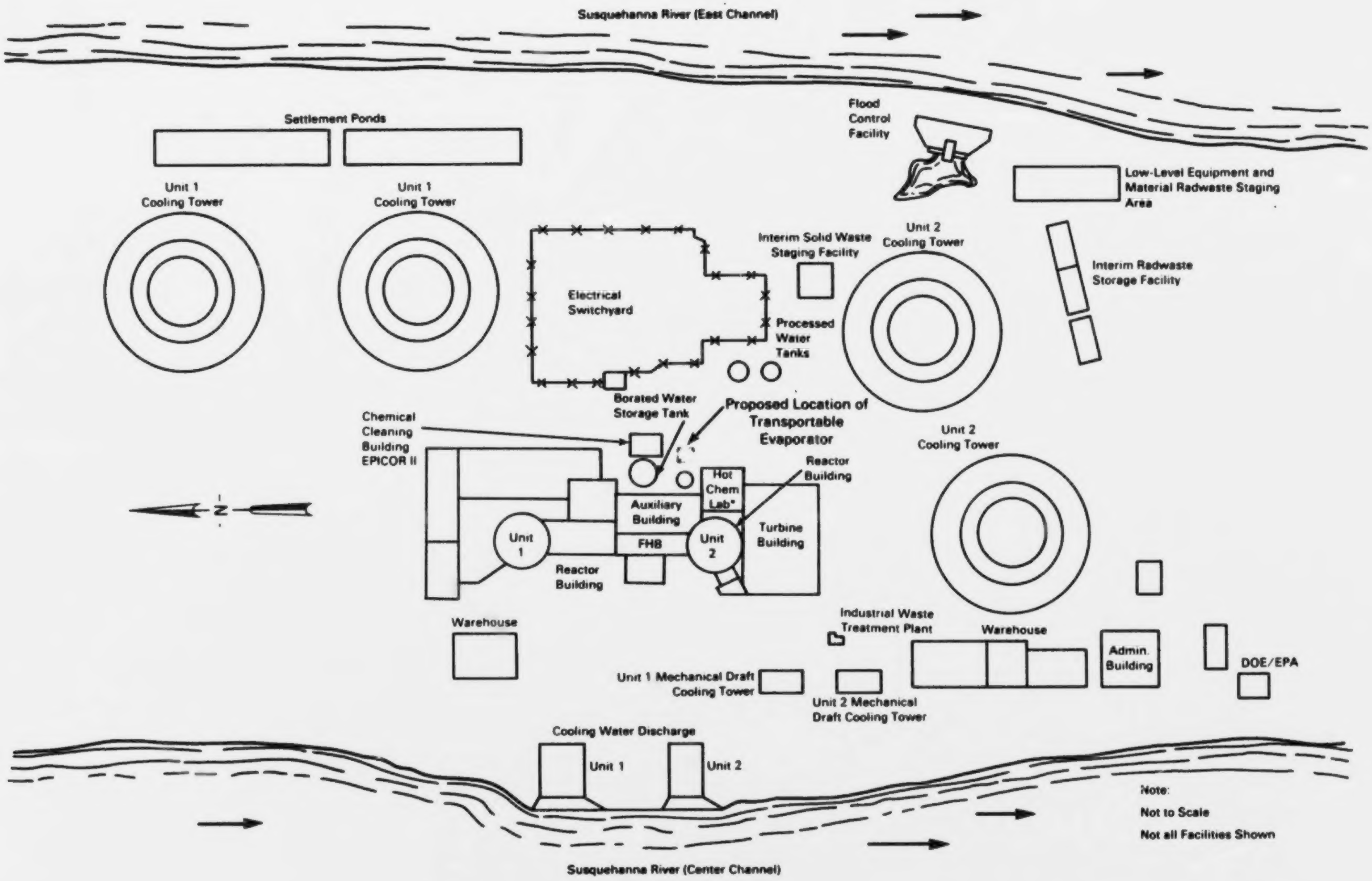
Susquehanna River (East Channel)
Settlement Ponds
Flood Control Facility
Low-Level Equipment and Material Radwaste Staging Area
Unit 1 Cooling Tower
Unit 1 Cooling Tower
Electrical Switchyard
Interim Solid Waste Staging Facility
Unit 2 Cooling Tower
Interim Radwaste Storage Facility
Processed Water Tanks
Borated Water Storage Tank
Proposed Location of Transportable Evaporator
Chemical Cleaning Building EPICOR II
Unit 2 Cooling Tower
Reactor Building
Hot Chem Lab*
Auxiliary Building
FHB
Unit 1
Unit 2
Turbine Building
Reactor Building
N
Warehouse
Industrial Waste Treatment Plant
Warehouse
Admin. Building
DOE/EPA
Unit 1 Mechanical Draft Cooling Tower
Unit 2 Mechanical Draft Cooling Tower
Cooling Water Discharge
Unit 1
Unit 2
Note:
Not to Scale
Not all Facilities Shown
Susquehanna River (Center Channel)

FIGURE 3.1. Proposed Evaporator Location

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TABLE 3.2. Characteristics of Evaporator Bottoms [letter and attachment from F. R. Standerfer (GPU Nuclear) to W. D. Travers (NRC), July 31, 1986]

Solids Concentration of Bottoms, wt%	Quantity of Bottoms, lb	Cement Binder-to-Bottoms Volume Ratio	Number of Liners[(a)]	Total Activity Per Liner, Ci	Burial Volume, ft^3
16	2,012,500	.35	271	.004507	46,022
16	2,012,500	.66	517	.002358	87,972
25	1,288,000	.35	161	.007587	27,332
25	1,288,000	.66	307	.003940	52,258

(a) Solidification liner size is 170 ft^3.

Chemical impurities frequently affect the curing rate and the final strength of concrete. Therefore, it may be necessary to control the boric acid and sodium ion content of the evaporator bottoms by incomplete evaporation, so that concrete of a sufficient strength can be produced. The measures used to improve concrete strength could increase the concreted waste volume to as much as 88,000 ft^3 (2,500 m^3), based on 0.66 cement binder-to-bottoms volume ratio for 16 wt% solids, as shown in Table 3.2).

The solidification process is expected to run concurrently with the evaporation process. Shipping could also run concurrently with the solidification process but with a lag of 1 to 2 months. The commercial LLW burial site operated by U.S. Ecology near Richland, Washington, is available to the licensee for a limited amount of waste. An emergency allocation of up to 46,000 ft^3 (1,300 m^3) of radioactive waste burial volume has been granted by DOE.(a) In preparing the supplement, the staff has assumed all shipments would be to the Richland site.

3.1.1.2 Environmental Impacts

Tritium would be released during the evaporation of the water. The rate of tritium release depends on the evaporator feed rate and the volume-reduction factor. A volume-reduction factor of 10 to 20 is expected to result in the release of approximately 90 to 95% of the tritium. At the maximum expected evaporation rate, the maximum release rate of the tritium has been estimated to be less than 160 µCi/sec, which is less than 30% of the continuous release rate (570 µCi/sec) permitted by the licensee's current technical specifications. The release would be from a stack [400 ft (120 m) above sea level, 100 ft (30 m) above ground], thereby decreasing the exposure to persons onsite and to nearby residents, compared with ground-level evaporation. As the concrete cures, about half of the remaining 5 to 10% of the tritium would be released at ground level. Assuming a solidification process rate of 2.0 gal/min (7.6 L/min) results in an average estimated tritium release rate of 8.2 µCi/sec (14% of the permitted continuous rate). Small amounts of tritium would remain in the concrete and slowly exchange with water in the environment before, during, or after transport.

The majority of the cesium and strontium would remain in the evaporator bottoms for solidification and subsequent burial. Small amounts of the strontium-90 and cesium-137 would be released to the atmosphere during evaporation. The fraction released would be dependent upon the concentration in the water input; the feed rate to the evaporator; the design of the evaporator; and the removal fraction from plate-out on the moisture separator, ducts, and stack. Releases of 0.1% or less of the total particulate are routinely achieved, and this release fraction has been assumed for the evaporator effluent. Based on the expected radionuclide concentration in the influent to the evaporator, the release rate for non-tritium radioactive

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(a) Letter from James W. Vaughn, Jr., Principal Deputy Assistant for Nuclear Energy, U.S. Department of Energy, to GPU Nuclear Corporation, February 11, 1987.

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material, principally cesium-137, strontium-90, and carbon-14, is expected to be 0.00028 μCi/sec. This rate is less than 1.2% of the continuous release rate permitted (0.024 μCi/sec) by the licensee's technical specifications. Any iodine-129 is assumed to be released with the vapor.

Transportation of the solidified material to Washington State would require approximately 80 to 135 truck shipments based on two 170-ft^3 (4.8-m^3) concreted resin liners per shipment (assuming a 0.35 cement binder-to-bottoms volume ratio and 25 and 16 wt% solids, respectively). The number of shipments may increase to 260 if a 0.66 cement binder-to-bottoms volume ratio is used for 16 wt% solids.

Occupational Radiation Exposure. The NRC staff has estimated that the operation of the evaporator will require from 7 to 11 person-rem of occupational exposure. This exposure is primarily due to the ambient radiation in the vicinity of the evaporator. Radiation exposure from the bulk liquid and the evaporator bottoms is negligible with respect to other sources (e.g. other radioactive wastes awaiting shipment) on the TMI site. Using the radionuclide concentrations expected to remain in the evaporator bottoms, a surface dose rate of less than 0.1 mrem/h was calculated for the entire volume of evaporator bottoms assuming no additional shielding.(a) Solidification of the evaporator bottoms would require an additional 5 to 9 person-rem for a total occupational exposure of 12 to 20 person-rem.

Radiation Exposure to the Public. The 50-year dose commitment(b) to the maximally exposed member of the public, as a result of processing the accident-generated water prescribed in this alternative, is calculated to be less than 4 mrem to the thyroid, 0.8 mrem to the bone, and 0.7 mrem to the total body. These calculations are based on a number of conservative assumptions. The maximally exposed individual is assumed to breathe air at the offsite boundary location of highest airborne concentration [0.34-mile (0.55-kilometer) west], and to consume food products raised exclusively in the offsite boundary location that receives the maximum ground deposition of the released radioactive material. The maximally exposed individual is in the age group that receives the highest dose.

The collective 50-year dose commitment to the affected population, an estimated 2.2 million people within a 50-mile (80-kilometer) radius, is calculated to be less than 6 person-rem to the thyroid, 0.2 person-rem to the bone, and 3 person-rem to the total body. The accumulated dose and the dose to the maximally exposed individual are calculated for the entire period. The bases for the calculations are given in Appendix C.

(a) Calculated using ISOSHLD-II computer code (Engel, Greenborg and Hendrickson 1966; Simmons et al. 1967).

(b) Fifty-year dose commitment is the total radiation received from initial exposure through the succeeding 50 years.

Commitment of Resources. Operation of a forced evaporation system would not involve any permanent commitment of land at the TMI site. Approximately 27,000 to 88,000 ft^3 (765 to 2,500 m^3) of solid radioactive waste would be generated from the solidified evaporator bottoms for disposal at a commercial LLW burial site.

The licensee estimated the cost for processed-water disposal by forced evaporation using a vendor-supplied transportable system and vendor solidification of the evaporator bottoms as ranging from $6.2 to 12 million depending on bottoms concentration and binder-to-bottoms volume ratio. This cost is broken down in Table 3.3.

TABLE 3.3. Cost Breakdown for Evaporation, Solidification of the Bottoms, and Disposal at a Licensed Burial Ground

Tasks	Cost, $ millions
Evaporation of 2.3 x 10^6 gallons of water	3.6
Solidification of evaporator bottoms at $33/$ft^3$	0.9 to 2.9
Transportation and burial of solidified bottoms at $63/$ft^3$	1.7 to 5.5
TOTAL	6.2 to 12.0

3.1.1.3 Accident Analysis

The accidents that have been considered include an onsite liquid release and a truck accident involving shipment of solidified evaporator bottoms.

A leak or spill caused by rupture of a storage tank used in this alternative, or a break, leak, or spill from the feed line to the evaporator or solidification system would result in the release of accident water or bottoms to the soil on the island. Even in the case of a very serious failure, not more than a few thousand gallons would likely reach the Susquehanna River via normal rainwater runoff channels. However, in the unlikely event where the entire inventory of an 11,000-gallon (42,000-liter) storage tank of accident-generated water prior to retreatment spills into the river, the estimated 50-year dose commitment to the maximally exposed individual will be 0.015 mrem to the bone and 0.002 mrem to the total body.

The calculations are based on a number of conservative assumptions. The maximally exposed individual is assumed to consume water and fish from the river as well as participate in recreation along the river banks. In addition, consumption of shellfish from the Chesapeake Bay at the maximum rate of 97 lb/yr (44 kg/yr) for the mid-Atlantic region (Rupp, Miller and Baes 1980)

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is assumed. Shellfish consumption contributes approximately 0.0012 mrem to the bone and 0.00004 mrem to the total body.

The collective 50-year dose commitment to the affected population (an estimated 300,000 people downstream from TMI and an unspecified population that consumes shellfish) would be 0.7 person-rem to the bone and 0.015 person-rem total body from drinking river water, consuming river fish and Chesapeake Bay shellfish, and engaging in recreation along the river banks. Shellfish consumption contributes 0.5 person-rem to the bone and 0.015 person-rem total body. The bases for these calculations are given in Appendix C.

A truck accident involving solidified evaporator bottoms is not likely to disperse the solidified waste, but could result in serious injuries or fatalities. Approximately 80 to 260 shipments between TMI and the commercial LLW burial site operated by U.S. Ecology near Richland, Washington would be required. For the 260-shipment case, 1.9 accidents involving a truck transporting waste are estimated to occur. For the 80-shipment case, 0.6 truck accidents are estimated to occur. The number of injuries and fatalities estimated for the 260-shipment case is about 1.6 and 0.13. The number of injuries and fatalities estimated for the 80-shipment case is 0.5 and 0.04.

3.1.1.4 Regulatory Considerations

The licensee's proposal to dispose of the accident-generated water must be approved by the Commission (Section 2.3). In addition, DOE approval to allocate emergency waste disposal volume is needed and has been received.

3.1.2 Evaporation, Solidification of Bottoms, and Retention Onsite

This alternative involves additional retreatment of all of the water and evaporation to the atmosphere in a commercial LLW evaporator, as described in Section 3.1.1. Forced evaporation of the accident-generated water would release most of the tritium, any iodine-129, and less than 0.1% of the other radionuclides and chemical contaminants to the atmosphere. The remaining radioactive and chemical contaminants would be concentrated in the evaporator bottoms. The residue would be solidified by mixing it with Portland cement. The concreted waste would then be placed in a lined trench onsite and covered for disposal. Some additional groundwater monitoring would be performed initially to assure that releases were as expected. Ultimate disposition of the site would not be affected by the presence of the concreted waste.

3.1.2.1 System Description and Operation

The evaporation would be performed as described in Section 3.1.1 except that all of the accident-generated water would be re-treated by the SDS and EPICOR II system to facilitate onsite disposal of the solidified waste. The types and quantities of contaminants expected to remain in the water are listed in Table 2.2 (in the Achievable Quantity and Concentration columns). Retreatment would generate 61 additional resin liners, 58 of which are 170 ft^3

(4.8 m^3) and 3 of which are 50 ft^3 (1.4 m^3), for a total volume of approximately 10,000 ft^3 (283 m^3). These resin liners would be disposed of as low-level radioactive waste by packaging and transporting to a commercial LLW burial site such as the one operated by U.S. Ecology near Richland, Washington.

The evaporation and concretion processes would be the same as described in Section 3.1.1 except that the wet concrete would be pumped directly into a prepared pit rather than formed in liners. A pit approximately 150,000 ft^3 ($4,250 \text{ m}^3$) in volume would be adapted or excavated. A 2-ft (0.64-m) layer of clay and a Hypalon® liner would provide groundwater protection. Leachate collection laterals would be placed on the liner and then covered with gravel and soil (shown in Figure 3.2). The collected leachate would be held and monitored in a sump located at the landfill site.

A trailer-mounted grouting system would be used to mix Portland cement with the bottoms and pump the mixture into the pit. A waste water/cement ratio of 0.35 to 0.66, depending on the requirements for complete solidification in a reasonable period of time, would be used.

The final volume of concrete would be between 27,000 and 88,000 ft^3 (765 and 2,500 m^3) depending on the percent of solids in the bottoms and the cement binder-to-bottoms ratio. Table 3.2 indicates the expected burial volume, based on the solids concentration and cement binder-to-bottoms volume ratio for solidification of the bottoms in liners. These would be the same for solidification in a trench. The time for the disposal of the evaporation bottoms will be dictated by the time required to evaporate the bulk of the accident water, 9 to 28 months. Following solidification, a Hypalon cap would be placed over the pit and at least 2 ft (0.64 m) of soil cover placed over that. The final covering of the pit will be completed approximately 5 months after the solidification.

To verify the containment capability of the pit, monitoring wells would be constructed up- and down-gradient of the pit. The water from these wells would be sampled at regular time intervals.

In the future, following decommissioning of both units, it is anticipated that the license would be terminated and the site released for unrestricted use. A discussion of the criteria and monitoring required prior to such release is beyond the scope of this report; however, the solidified material retained onsite is not expected to impact this disposition because of the very low doses that would result from any future use.

3.1.2.2 Environmental Impacts

About 90 to 95% of the tritium would be released to the atmosphere during evaporation. As explained in Section 3.1.1.2, at the expected evaporation rate, the release rate of the tritium has been estimated to be less than

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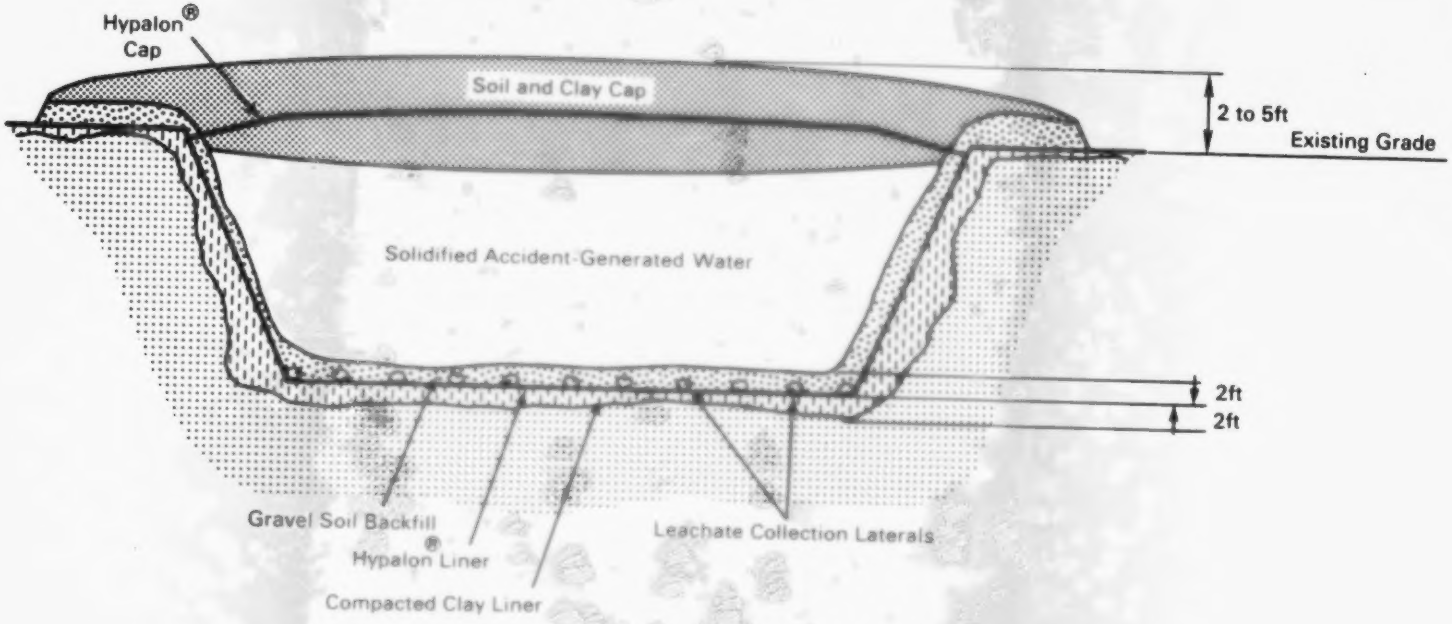
Hypalon® Cap
Soil and Clay Cap
2 to 5ft
Existing Grade
Solidified Accident-Generated Water
2ft
2ft
Gravel Soil Backfill
Hypalon® Liner
Compacted Clay Liner
Leachate Collection Laterals

FIGURE 3.2. Conceptual Landfill Cross Section

160 μCi/sec, which is less than 30% of the continuous release rate (570 μCi/sec) permitted by the licensee's technical specifications. About half of the remaining 5 to 10% of the tritium would be released to the atmosphere during curing of the concrete. Assuming a solidification processing rate of 2.0 gal/min (7.6 L/min) results in an average estimated tritium release rate of 8.2 μCi/sec (14% of the permitted continuous release rate). A small amount would remain in the concrete and slowly exchange with water in the environment over a period of several years.

The majority (all but about 0.1% as estimated for evaporator operation in Section 3.1.1.2) of the cesium, strontium, and carbon in the accident-generated water would remain in the evaporator bottoms and be solidified with the concrete. The release rate for non-tritium radioactive material during evaporation (principally cesium-137, strontium-90, and carbon-14) is expected to be 2.6×10^{-6} μCi/sec, which is approximately 0.01% of the permitted continuous release rate (0.024 μCi/sec). The concentrations of cesium, strontium, and tritium in the concrete when it is formed and at the end of 30 years, based on radioactive decay and assuming no migration or atmospheric exchanges, are shown in Table 3.4. The earliest that the site might be released for unrestricted use (based on the assumed continued operation of Unit 1) is estimated to be 30 years. In several decades, most of the cesium and strontium would eventually leach from the concrete after the liner fails. The leachate would not be expected to reach the river for several more decades because of ion exchange with site soils (NRC 1981, Appendix V).

TABLE 3.4. Radionuclide Concentrations in the Concreted Evaporator Bottoms

	Concentration When Cured, μCi/g	Anticipated Maximum Concentration After 30 Years, μCi/g
Cesium-137	4.4×10^{-6} to 3.7×10^{-5}	2.2×10^{-6} to 1.8×10^{-5}
Strontium-90	1.2×10^{-5} to 9.8×10^{-5}	5.6×10^{-6} to 4.6×10^{-5}
Tritium (Hydrogen-3)	7.5×10^{-3} to 6.2×10^{-2}	1.4×10^{-3} to 1.1×10^{-2}
Carbon-14	1.3×10^{-4} to 1.1×10^{-3}	1.3×10^{-4} to 1.1×10^{-3}
Iodine-129	$<7.8 \times 10^{-9}$ to 6.4×10^{-7}	$<7.8 \times 10^{-9}$ to 6.4×10^{-7}

Occupational Radiation Exposure. The retreatment of the remaining accident-generated water would result in approximately 2 to 5 person-rem of occupational exposure. As discussed in Section 3.1.1.2, evaporation would result in 7 to 11 person-rem of occupational radiation exposure and solidification would result in an additional 5 to 9 person-rem. The total occupational exposure would be 14 to 25 person-rem.

Radiation Exposure to the Public. The 50-year dose commitment to the maximally exposed member of the public (as described in Section 3.1.1.2) from the atmospheric releases is estimated to be less than 4 mrem to the thyroid, 0.8 mrem to the bone, and 0.7 mrem to the total body. The collective 50-year dose commitment to the 2.2 million people within a 50-mile (80-kilometer) radius is estimated to be less than 6 person-rem to the thyroid and 3 person-rem to the total body.

From the material that could eventually be released to the Susquehanna River from the leachate, the maximally exposed individual would receive a 50-year dose commitment of 0.0004 mrem to the bone and 0.00004 mrem to the total body from 5.1 curies of tritium, 0.0008 curies of strontium-90, and 0.0003 curies of cesium-137. These calculations are based on a number of conservative assumptions. The maximally exposed individual is assumed to ingest water and fish from the river and participate in recreational activities on the river such as swimming and boating. The collective 50-year dose commitment to the affected population (an estimated 300,000 people downstream from TMI) from eventual liquid releases is estimated to be 0.03 person-rem to the bone and 0.002 person-rem to the total body.

This alternative also presumes ultimate release of the reactor site after approximately 30 years with the concreted waste remaining in place. At that time, the site might be used for other purposes, including construction of residences, farming, cattle, grazing, etc. The NRC has adopted the De Minimis Waste Impacts Analysis Methodology (Oztunali and Roles 1984) for estimating postdisposal impacts. Using this methodology and the concentration shown in Table 3.4, a dose to the maximally exposed individual of 0.5 mrem/yr to the bone and 0.5 mrem/yr total body has been calculated. This calculation assumes that the maximally exposed individual is exposed to leachate from the waste, consumes food grown on the site, participates in construction on the site, and uses well water from the site.

Commitment of Resources. This alternative would commit a land area on the TMI site of approximately 15,000 ft^2 (1,400 m^2) for storage of the concreted evaporator bottoms until verification of expected future dose was confirmed, at which time some future user might still be affected by the presence of concrete. This alternative would also require approximately 10,000 ft^3 (283 m^3) of burial spaces at a commercial LLW burial site for the resin liners from treatment of the accident-generated water.

The estimated cost for completion of this alternative is $6.7 to 8.8 million. This cost is broken down in Table 3.5.

The radiological monitoring costs include groundwater monitoring wells and surveillance programs to verify that the 10 CFR 20.302 and criteria of the Commonwealth of Pennsylvania have been met. Upon completion of pit closure, the surveillance program would be included in the overall TMI site program with little additional cost.

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TABLE 3.5. Cost Breakdown for Evaporation, Solidification of Bottoms, and Retention Onsite

Tasks	Cost, $ millions
Retreatment of water (includes transportation and burial of resin liners)	2.3
Evaporation of water	3.6
Solidification and burial onsite	0.7 to 2.6
Radiological monitoring	0.1 to 0.3
TOTAL	6.7 to 8.8

3.1.2.3 Accident Analysis

The accidents that have been identified for consideration in this alternative include an onsite liquid release and truck accident in the shipment of resin liners.

If the solidification runs concurrent with evaporation, any accident that is feasible for the solidification process has insignificant radiological consequences compared with the accidents possible in the evaporation of the accident water. The analysis of accidents during the evaporation process is the same as that given in Section 3.1.1.3 with the exception of the trucking accidents.

A truck accident involving a shipment of the resin liners, which are shipped in Type B containers, is not likely to have radiological consequences but could result in serious injuries or fatalities. Approximately 60 shipments will be required between TMI and the commercial LLW burial site operated by U.S. Ecology near Richland, Washington. For the 60 truck shipments, the staff has estimated 0.5 accidents, 0.4 injuries, and 0.03 fatalities.

3.1.2.4 Regulatory Considerations

Commission approval pursuant to 10 CFR 20.302 (Section 2.3.2) would be required. Approval would require a determination that the level of radioactivity in the material to be buried is below regulatory concern. The principal controlling criterion for such disposal would be the condition that the maximum dose to any member of the public would be acceptably low (i.e., less than 10 mrem/yr) under all possible circumstances. The Commonwealth of Pennsylvania would also be involved in the approval of the site as a landfill.

3.1.3 Distillation, Solidification, and Disposal of Bottoms; River Discharge of Distillate

This alternative involves closed cycle evaporation of the accident-generated water and differs from the licensee's proposal only in the disposition of the gaseous effluent from the evaporator. Rather than releasing the effluent as a gas to the environment, it would be condensed, sampled, and discharged to the Susquehanna River.

Alternatives involving closed cycle evaporation were not considered in the draft supplement but were added in response to comments received. In addition to this alternative involving closed cycle evaporation, two other alternatives involving closed cycle evaporation were rejected (see Sections 3.6.4 and 3.6.5).

3.1.3.1 System Description and Operation

Before discharge to the river, the base-case accident-generated water would be distilled in a commercial low-level waste evaporator, as discussed in Section 3.1.1.1, except that the evaporator would be operated in a closed cycle mode and the condensate collected and sampled before discharge to the river. The contents of evaporator bottoms would be the same as those for closed cycle evaporation and they could be disposed of as the licensee has proposed: concretion and shipment to a commercial LLW burial site. Airborne effluent from the evaporator would be essentially zero.

The distilled waste-water stream would be pumped from the evaporator to one of two evaporator condensate test tanks and a representative sample taken to verify the concentration of contaminants. The water would then be discharged to the river. This water would contain only 0.1% of the boron, sodium, and particulate radionuclides, but would contain at least 90% of the tritium (100% was assumed in dose calculations). There are also volatile forms of iodine-129 that, although not detected, might be present at or below the detection limit and these would not be reduced by the distillation process. Expected maximum concentrations and quantities are shown in Table 3.6.

The dose is independent of the time period over which the discharge occurs; however, a 1-year discharge at the average annual flow of 34,000 cfs was assumed.

3.1.3.2 Environmental Impacts

The downstream population would be exposed to the accident-generated water in a highly diluted form through the drinking water treatment plant influent, direct exposure, and the consumption of fish and shellfish.

Occupational Radiation Exposure. The occupational radiation exposure required for completion of this alternative includes 7 to 11 person-rem for evaporator operation, 5 to 9 person-rem for solidification of the bottoms, and 0.5 to 2 person-rem for river discharge. In every case, the dose from the

TABLE 3.6. Expected Quantities and Concentrations of Contaminants in Distilled Accident-Generated Water[a]

Constitution	Total Quantity, Ci	Concentration, µCi/ml
Total Volume	2 to 2.3 million gallons	-
Tritium	9.2×10^{2} to 1.02×10^{3}	1.3×10^{-1}
Cesium-137	3.2×10^{-4}	3.7×10^{-8}
Cesium-134	7.7×10^{-6}	8.8×10^{-10}
Strontium-90	9.6×10^{-4}	1.1×10^{-4}
Antimony-125/ Tellurium-125	2×10^{-5}	2.3×10^{-9}
Carbon-14	8.7×10^{-4}	1.0×10^{-7}
Technetium-99	8.7×10^{-7}	1.0×10^{-9}
Iron-55	4.2×10^{-6}	4.8×10^{-10}
Cobalt-60	4.2×10^{-6}	4.8×10^{-10}
Boron	30 pounds	3 ppm B
Sodium	2.2 pounds	0.7 ppm Na^{+}

(a) All other radionuclides would be less than the detection limit listed in Table 2.2.

water would be negligible, but other sources at the site would contribute some dose. This results in a total estimate of 12.5 to 22 person-rem for this alternative.

Public Radiation Exposure. The maximally exposed individual could receive a 50-year dose commitment of up to 0.01 mrem to the thyroid (assuming iodine-129 is present at the detection limit), approximately 0.003 mrem to the bone, and approximately 0.002 mrem to the total body. The maximally exposed individual is a person who consumes Susquehanna River water and fish and participates in rivershore activities including bathing and swimming. In addition, this individual is assumed to consume shellfish from Chesapeake Bay at a maximum rate of shellfish consumption for the mid-Atlantic region, 97 lb/yr or 44 kg/yr (Rupp, Miller and Baes 1980). Shellfish consumption contributes 0.003 mrem to the thyroid, approximately 0.0002 mrem to the bone, and approximately 0.0001 mrem to the total body dose. The time period of the discharge would not materially affect the total dose received, but would affect the rate at which the dose was received.

The total 50-year dose commitment to the population that uses Susquehanna River water, and consumes drinking water and fish from the river and shellfish from Chesapeake Bay, from the discharge of the water is estimated to be up to 1.3 person-rem to the thyroid, approximately 0.14 person-rem to the bone, and approximately 0.6 person-rem to the total body. Shellfish consumption from the Chesapeake Bay contributes up to 0.005 person-rem to the thyroid, approximately 0.0004 person-rem to the bone, and approximately 0.0002 person-rem to the total body. The total population dose received would not be materially affected by the time period over which the discharge occurred. However, it would be affected by the river flow rate.

Commitment of Resources. No permanent land commitment is anticipated although approximately 27,000 to 88,000 ft^3 (765 to 2,500 m^3) of burial space would be required for the solidified evaporator bottoms at the commercial LLW burial site. This alternative, distillation of the accident-generated water, disposal of the evaporator bottoms, and discharge to the Susquehanna River, is estimated to cost from \$6.3 to 12.6 million. This cost is broken down in Table 3.7.

TABLE 3.7. Cost Breakdown for Distillation, Solidification, and Disposal of Bottoms and River Discharge of Distillate

Tasks	Cost, \$ millions
Distillation of the water	3.6 to 4.0
Solidification of evaporator bottoms at \$33/ft^3	0.9 to 2.9
Transportation and burial of solidified bottoms at \$63/ft^3	1.7 to 5.5
Monitoring and discharge costs	0.1 to 0.2
TOTAL	6.3 to 12.6

3.1.3.3 Accident Analysis

The potential accidents that have been considered for this alternative are the discharge of batches of the accident-generated water before it is evaporated as well as transportation accidents during the shipment of the solidified evaporator bottoms to the commercial LLW burial site.

The discharge of a batch of accident-generated water before retreatment is highly unlikely; however, the release of water from a storage tank containing approximately 11,000 gallons (42,000 liters) would result in the doses discussed in Section 3.1.1.3.

Accidents occurring during the shipment of solidified evaporator bottoms to the LLW disposal site are addressed in Section 3.1.1.3.

3.1.3.4 Regulatory Considerations

Any disposal method for the accident-generated water must be approved by the Commission (Section 2.3). DOE approval for the allocation of emergency waste disposal volume is also needed and has been received. The EPA requirements of 40 CFR 141 and 190, as discussed in Section 2.3.1, must be met. The 10 CFR 20 Appendix B limits for radioisotope concentrations in air and water above background in unrestricted areas apply (see Table 2.5) as do the station technical specification limits. The NDPES permit issued September 19, 1986, and discussed in Section 2.3.4, restricts the pH of liquid discharges to between 6.0 and 9.0 but specific prior PaDER approval would not be required because essentially no boron would be involved.

3.2 ALTERNATIVES INVOLVING BULK LIQUID SHIPMENT

One feasible disposal method involves bulk shipment of accident-generated water and pond evaporation at the DOE's Nevada Test Site (NTS). Other alternatives involving bulk liquid shipment were considered and rejected. Bulk shipment in 5,000-gallon (19,000-liter) tank trucks is considered more practical than packaged shipment in 55-gallon (200-liter) drums. Bulk rail shipment of accident-generated water might prove feasible but truck shipment was considered more likely. Approximately 420 truck shipments each containing 2.5 curies of tritium, plus traces of cesium and strontium, would be required. Shipment by tank trucks is allowed[a] under the provision of 49 CFR 173.425c, and would require about 9 to 18 months, depending on the number of trucks available. (Trailer or flat-car service is not allowed.)

3.2.1 Offsite Evaporation at the Nevada Test Site

Implementation of this alternative involves loading the accident-generated water into tank trucks and transporting it to a specially constructed, lined pond at NTS. The water, including the tritium, would evaporate from the pond and the remaining solids would either be capped with concrete and covered with soil, or covered with soil only and vitrified in situ. In situ vitrification is equivalent in environmental impact to the concrete and soil cover and might prove less costly.

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[a] Low specific-activity liquid radioactive materials may be transported in exclusive-use vehicles without bottom openings in tanks if the average estimated concentration does not exceed 0.001 mCi/g and the concentration of specified radioisotopes (actinium-227; americium-241 and -242; californium-249, -250, and -252; curium-242, -243, -244, -245, and -246); neptunium-237; protactinium-231; plutonium-238, -239, and -242; thorium-228 and -230; and uranium-232) does not exceed 1% of the total radioactivity. The total activity in the water is approximately 0.0001 mCi/g and the percentage of the specified isotopes is less than 0.0006%.

3.2.1.1 System Description and Operation

A Hypalon-lined pond with a capacity of approximately 1 million gallons (3.87 million liters) and a surface area of approximately 15,000 ft^2 (1,400 m^2) would be constructed at NTS. The accident-generated water would be transported in 5,000-gallon (19,000-liter) tank trucks (approximately 420 truck shipments would be required) and placed in the pond where natural evaporation would take place. The evaporation rate would nearly equal the shipment rate.

The tritium would be released to the atmosphere at the same rate that the water is evaporated until approximately 90% of the water is evaporated. At that time, the rate of evaporation would slow because of the inhibiting effect of the remaining concentrated salts, but the tritium would continue to be lost to the atmosphere by isotopic exchange with water vapor in the air until the tritium level in the remaining salts approaches background level. The evaporation residues could then be disposed of in place by covering them with concrete, and then a layer of soil.

Another method of disposal might be in situ vitrification. In this method the residues are covered with soil, electrodes are introduced, and a current is passed through the residues and soil to melt them into glass (Oma et al. 1983).

3.2.1.2 Environmental Impacts

Environmental impacts arise from loading the approximately 420 truck shipments, the evaporation of water and the release of essentially 100% of the tritium in Nevada and the disposal of the remaining waste in Nevada.

Occupational Radiation Exposure. Loading trucks at TMI is expected to result in 0.5 to 1 person-rem of occupational radiation exposure. This dose results primarily from exposure to sources on the TMI site other than the accident-generated water. Thus, occupational exposure at NTS, where the only source of exposure is the accident-generated water, could be controlled by assuring that personnel remain upwind and do not approach the pond when the concentration of tritium in the air approaches the maximum permissible concentration (MPC) prescribed in 10 CFR 20. Although there would be a few MPC-hours of exposure associated with this alternative during unloading of the accident-generated water and during the evaporation process, exposure would be minimized by proper site selection and operating procedures. Total occupational dose would be between 0.5 and 1 person-rem.

Radiation Exposure to the Public. The collective 50-year dose commitment to the affected population (estimated to be 6,400) within a 50-mile (80-kilometer) radius of the proposed disposal site at NTS would be 0.0003 person-rem. This dose occurs during the evaporation and continues during consumption of crops grown downwind. Dose from the residue will be negligible once it is covered. Because all the offsite population is at least 27 miles (43 kilometers) away, no dose to a maximally exposed individual was calculated in this alternative.

Commitment of Resources. Evaporation of the accident-generated water at NTS and covering the waste disposal site would commit approximately 15,000 ft^2 (1,400 m^2) of land. Disposal of the accident water via pond evaporation at NTS is estimated to cost approximately $2.5 to 3.4 million. This cost is broken down in Table 3.8.

TABLE 3.8. Cost Breakdown for Offsite Evaporation at the Nevada Test Site

Tasks	Cost, $ millions
Construction and closure of pond	0.2 to 0.6
Operation and monitoring	0.2 to 0.7
Transportation	2.1
TOTAL	2.5 to 3.4

3.2.1.3 Accident Analysis

The accidents that have been identified for consideration in this alternative include truck accidents on- or offsite.

The maximum credible accident associated with alternatives involving bulk liquid shipment involves an accident in which the contents of the 5,000-gallon (19,000-liter) tank on a truck are released at one time. In the case where the 5,000 gallons (19,000 liters) is released directly into the Susquehanna River because of a truck accident on or near the site, the additional dose to the public would be less than 50% of that estimated for the total discharge of 11,000-gallon (42,000-liter) storage tank containing untreated accident-generated water to the river (see Section 3.1.1.3).

During transit, if the tank failed and the accident-generated water were released onto the roadway, for a short time airborne tritium concentrations might exceed occupational limits in the immediate vicinity of the accident. However, the majority of the accident-generated water would drain off the roadway and be absorbed into the soil. The approximately 125 pounds (56.7 kilograms) of boron in the accident-generated water transported by one truck would likely kill or stunt any vegetation growing where the spill occurred. Plant growth would be impaired until the boron concentration in the soil was reduced from 3,000 ppm to a concentration of 1 to 4 ppm. The dose to the total body of the maximally exposed individual, assuming the individual spent 2 hours at the accident site, would be on the order of 0.2 mrem. The 50-year dose commitment to an individual consuming 50 pounds (23 kilograms) of produce harvested 14 days after the accident, from the one-quarter acre of soil where the accident-generated water was absorbed (after the boron concentration had been reduced to innocuous levels and assuming no reduction in the

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radionuclide concentration), could be up to 60 mrem total body and 3,000 mrem to the bone. If the duration between the spill and harvest were greater, the dose would be less.

The one-way shipping distance from TMI to NTS is 2,612 miles (4,203 kilometers). Calculations indicate that about 1.5 accidents are likely to occur in the 1.1 million miles that waste is transported and another 1.5 accidents are likely on the return trips. These accidents will not necessarily result in the spilling of the loaded accident-generated water, however, a total of 2.6 injuries and 0.2 fatalities were estimated to result from these accidents.

3.2.1.4 Regulatory Considerations

Both NRC and DOE approval would be required for the disposal of waste described in this alternative. The Memorandum of Understanding[a] between agencies does not include any commitment for DOE to accept TMI waste that can be disposed of by commercial means.

3.3 ALTERNATIVES INVOLVING DIRECT SOLIDIFICATION

Solidification of radioactive liquids is frequently used to facilitate safe transport and/or burial. Two alternatives involving direct solidification were considered: 1) permanent onsite storage and 2) solidification and shipment to a commercial LLW burial site.

3.3.1 Permanent Onsite Storage of Solidified Waste

This alternative assumes the retreatment of the water (achievable case). The processed water would then be mixed with Portland cement and cast into a previously prepared trench onsite. The concrete would be expected to remain at TMI beyond the time that the licensee maintained control of the site.

The licensee evaluated the solidification and onsite burial with the objective of reducing the radionuclide inventory to a level such that NRC approval of onsite disposal could be sought under the provisions of 10 CFR 20.302. Approval by the Commonwealth of Pennsylvania would also be required.

3.3.1.1 System Description and Operation

Prior to solidification, all accident-generated water would be re-treated by the SDS and/or the EPICOR II system to reduce the strontium-90 and the cesium-137 concentrations. The types and quantities of contaminants expected

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(a) Memorandum of Understanding between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy concerning the removal and disposition of solid nuclear waste from cleanup of the Three Mile Island Unit 2 Nuclear Plant, March 15, 1982. A copy of the Memorandum of Understanding is available in the NRC Reading Room.

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to remain in the accident-generated water are given in Table 2.2 (in the Achievable Quantity and Concentration columns). Retreatment would generate an additional 61 resin liners, for a total volume of approximately 10,000 ft^3 (283 m^3). These resin liners would be disposed of as low-level radioactive waste at the commercial LLW burial site operated by U.S. Ecology near Richland, Washington.

A 260- by 190- by 15-ft (79- by 58- by 4.6-m) pit (similar to Figure 3.2) would be excavated and lined with 2 ft (0.64 m) of clay followed by a Hypalon liner. Leachate collection laterals would be placed directly on the liner and the entire pit bottom would be covered with gravel and soil. A trailer-mounted grouting system would be used to mix Portland cement with the accident-generated water and to pump the resulting slurry into the pit. The formulations considered by the licensee include the use of Type 1 Portland cement or masonry cement with the water-to-cement ratios between 0.5 and 0.75 by weight. The concrete volume would range between 390,000 and 460,000 ft^3 (11,000 and 13,000 m^3) depending on the cement used and the water-to-cement ratio. The hardened concrete would be covered with a Hypalon cover and approximately 2 feet (0.64 meter) of soil.

Wells would be constructed to monitor the groundwater. One monitoring well would be constructed up-gradient and the rest would be constructed down-gradient of the groundwater flow paths. Collected leachate, held in a sump located at the landfill site, would be monitored.

It is anticipated that 39 weeks would be required to complete operations including excavating the disposal pit, erecting the grouting system, completing the grouting operations and completing the backfill operations. This time estimation is based on operating approximately 50% of the time.

3.3.1.2 Environmental Impacts

Approximately one half of the tritiated water would be released to the atmosphere during the concrete curing processes. Assuming a solidification system that processes water at a rate of 10 gal/min (38 L/min), 5 gal/min (19 L/min) would evaporate during curing, releasing tritium at an estimated maximum rate of 41 μCi/sec. This rate is 7% of the TMI-2 Technical Specifications limits (570 μCi/sec). The remaining 50% of the tritiated water would slowly exchange with environmental water until the tritium concentrations were equal. In several decades, cesium and strontium would eventually leach from the concrete after the liner fails. The leachate would not be expected to reach the river for several more decades because of ion exchange with site soils (NRC 1981, Appendix V).

Occupational Radiation Exposure. This alternative is estimated to result in 2 to 5 person-rem from retreatment of the water and 9 to 11 person-rem from casting the concrete. Occupational exposure during concrete casting would come from other sources at the site, not the water or concrete. Several hundred hours of exposure to airborne tritium would also result in additional dose that is released during the concrete curing. The total occupational exposure would be approximately 12 to 17 person-rem.

Radiation Exposure to the Public. The tritium that is released during the concrete curing will leave the site in a gaseous state and will become a potential source of exposure to the public. The staff has estimated that the maximally exposed individual (as described in Section 3.1.1.2) will receive a 50-year dose commitment of 5 mrem to the total body from the 1020 curies of tritium that will be released to the atmosphere. Half will be released initially during curing and half later.

The collective 50-year dose commitment to the affected population, approximately 2.2 million people within a 50-mile (80-kilometer) radius, is estimated to be 3 person-rem to the total body. From the material that could eventually be released to the river from the leachate (5.1 curies of tritium, 0.008 curies of strontium-90, and 0.003 curies of cesium-137), the maximally exposed individual (as described in Section 3.1.1.3) will receive a 50-year dose commitment of 0.0004 mrem to the bone and 0.00004 mrem to the total body. The collective 50-year dose commitment from the eventual liquid release to the affected population (approximately 300,000 people downstream of TMI) is estimated to be 0.03 person-rem to the bone and 0.002 person-rem to the total body.

This alternative also presumes ultimate release of the reactor site after approximately 30 years with the concreted waste remaining in place. At that time the site might be used for other purposes, including construction of residences, farming, cattle, grazing, etc. The NRC has adopted the De Minimis Waste Impacts Analysis Methodology (Oztunali and Roles 1984) for estimating postdisposal impacts. Using the methodology and the concentration shown in Table 3.9, a dose to the maximally exposed individual of 0.8 mrem/yr to the bone and 0.8 mrem/yr to the total body has been calculated. The bases for these calculations are the same as those that are used in Section 3.1.2.2 (all doses are from potential uptake of radionuclides because there is essentially no gamma whole body component).

TABLE 3.9. Radionuclide Concentrations in the Concreted Waste

	Concentration When Cured, µCi/g	Anticipated Maximum Concentration After 30 Years, µCi/g
Cesium-137	9.2×10^{-7} to 1.1×10^{-6}	4.6×10^{-7} to 5.5×10^{-7}
Strontium-90	2.5×10^{-6} to 2.9×10^{-6}	1.2×10^{-6} to 1.4×10^{-6}
Tritium (Hydrogen-3)	1.6×10^{-2} to 1.8×10^{-2}	1.9×10^{-3} to 3.4×10^{-3}
Carbon-14	2.5×10^{-5} to 3.2×10^{-5}	2.5×10^{-5} to 3.2×10^{-5}
Iodine-129	$<1.5 \times 10^{-7}$ to 1.8×10^{-7}	$<1.5 \times 10^{-7}$ to 1.9×10^{-7}

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Commitment of Resources. This alternative would involve a relatively long-term commitment of approximately 49,000 ft^2 (4,600 m^2) of land onsite. It would also require approximately 10,000 ft^3 (283 m^3) of burial space at the commercial LLW burial site operated by U.S. Ecology near Richland, Washington, for the resin liners from re-treating the additional accident-generated water.

The estimated cost of retreatment of the accident-generated water, solidification, and disposal onsite ranges from $5.4 to 6.0 million. This cost is broken down in Table 3.10.

TABLE 3.10. Cost Breakdown for Permanent Onsite Storage of Solidified Waste

Tasks	Cost, $ millions
Retreatment of water (includes transportation and burial of resin liners)	2.3
Construction and close of pit	0.2 to 0.5
Solidification system	1.5
Solidification processing	1.3 to 1.5
Surveillance and monitoring	0.1 to 0.2
TOTAL	5.4 to 6.0

3.3.1.3 Accident Analysis

Credible accidents are unlikely to result in the release of accident-generated water offsite. Accidents occurring during the shipment of the resin liners to the LLW burial site are addressed in Section 3.1.2.3.

3.3.1.4 Regulatory Considerations

Nuclear Regulatory Commission approval pursuant to 10 CFR 20.302 (Section 2.3.2) would be required. Approval would require a determination that the level of radioactivity in the material to be buried is below regulatory concern. Approval by the Commonwealth of Pennsylvania would also be required to dispose of any waste on the TMI site.

3.3.2 Solidification and Disposal at a Commercial Low-Level Burial Site

This alternative requires the direct solidification of all of the accident-generated water and disposal at a commercial LLW burial site. Although the accident-generated water can be transported as bulk liquid, this

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alternative assumes that solidification would be performed onsite at TMI. Approximately 1300 to 1600 shipments would be required to move the solidified waste to the commercial LLW burial site operated by U.S. Ecology near Richland, Washington.

3.3.2.1 System Description and Operation

Retreatment of the accident-generated water would not be performed for this alternative. Solidification would be virtually the same process described for onsite storage in Section 3.3.1 with the following exceptions:

- A water-to-cement ratio between 0.5 and 0.6 would be used to ensure the integrity of the concrete for transfer to a storage site.
- The concrete would be discharged from the grouting system into approximately 4- by 6- by 12-ft (1.2- by 1.8- by 3.7-m) forms.
- Following a minimum 28-day cure period, the blocks would be coated with asphalt and boxed (or shipped in enclosed "exclusive use" vehicles).

After these steps have been followed, the blocks would be trucked to the commercial LLW burial site operated by U.S. Ecology near Richland, Washington. The total volume of concrete would range from 390,000 to 460,000 ft^3 (11,000 to 13,000 m^3) depending on the water/cement ratio. This would require 1300 to 1600 shipments based on one block per shipment. The solidification process would be expected to require approximately 6 months, and the shipping process approximately 12 months.

3.3.2.2 Environmental Impacts

During concrete mixing and curing, approximately 50% of the water and tritium would be evaporated to the atmosphere. Assuming a solidification system that would process water at the rate of 10 gal/min (38 L/min), 5 gal/min (19 L/min) would evaporate and release tritium at an estimated maximum rate of 41 µCi/sec. This rate is 7% of the TMI-2 technical specification limit (570 µCi/sec). The remaining tritium would slowly exchange with water in the environs before, during, and after transport.

Occupational Radiation Exposure. The occupational radiation exposure to perform this alternative would include 5 to 9 person-rem for solidification and coating and 1 to 4 person-rem to package and load the solidified material for transport. This exposure is primarily due to ambient radiation in the vicinity of the solidification equipment. Radiation exposure from the bulk liquid and solidified waste is negligible with respect to other sources on the TMI site. A total dose of 6 to 13 person-rem is therefore estimated. Unloading would result in very little additional occupational exposure.

Radiation Exposure to the Public. The released tritium would leave the site in a gaseous state and will become a source of exposure to the public. The staff has estimated that the maximally-exposed individual (as described in

Section 3.1.1.2) will receive a 50-year dose commitment of 2 mrem to the total body from the 510 curies of tritium that will be released to the atmosphere. These releases were estimated to result in a 50-year dose commitment (total body) to the 2.2 million people within a 50-mile (80-kilometer) radius of approximately 1.5 person-rem.

Commitment of Resources. This alternative would not involve any permanent commitment of land at the TMI site. It would generate 390,000 to 460,000 ft^3 (11,000 to 13,000 m^3) of solid radioactive waste for disposal at a commercial LLW burial site.

This alternative would cost from $34 to 41 million. The cost is broken down in Table 3.11.

TABLE 3.11. Cost Breakdown for Solidification and Disposal at a Commercial Low-Level Burial Site

Tasks	Cost, $ millions
Solidification and packaging	13 to 15
Transportation and burial	21 to 26
TOTAL	34 to 41

3.3.2.3 Accident Analysis

Credible accidents onsite are unlikely to release accident-generated-water to the river as discussed in Section 3.1.1.3.

Offsite truck accidents involving the solidified waste material are not expected to result in radiological consequences because the radionuclide concentrations are extremely low and the waste form (cement) is relatively strong and durable. However, should a truck accident occur, fatalities and injuries may result. It was estimated that 10 to 12 accidents could occur (depending on the final waste volume) as a result of shipping the solidified waste products from TMI to the LLW burial site operated by U.S. Ecology near Richland, Washington. The staff estimated that 8.2 to 10 injuries would result from the projected accidents over the shipping campaign. The number of fatalities that would result from these accidents was estimated at 0.6 to 0.8.

3.3.2.4 Regulatory Considerations

As discussed in Section 3.1.1.4, the use of this waste disposal method requires not only the approval by the Commission, but is also likely to require the allocation of emergency waste disposal volume by the DOE. This disposal method would require a very significant portion of the available emergency allocation.

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3.4 ALTERNATIVES INVOLVING RIVER DISCHARGE

Two cases of controlled discharges to the Susquehanna River were considered: long-term and short-term discharge. These cases are discussed in this section.

3.4.1 Long-Term River Discharge

This alternative for disposal of the accident-generated water involves controlled discharge to the Susquehanna River over a span of two or three years. This alternative assumes that prior to discharge to the Susquehanna River, all of the accident-generated water would be re-treated to assure that the concentration of radioactive material in the effluents is minimized. The water would then be sampled and mixed with letdown water from the mechanical draft cooling tower and released to the river.

3.4.1.1 System Description and Operation

Before discharge to the river, the accident-generated water would be re-treated through the SDS and/or the EPICOR II water purification system to further reduce the radionuclide concentrations. The types and quantities of contaminants expected to remain in the water are given in Table 2.2 (in the Achievable Quantity and Concentration columns). The tritium and borate concentrations would remain essentially unchanged. Retreatment would generate an additional 61 resin liners for a total volume of approximately 10,000 ft^3 (283 m^3). These would be disposed of as low-level radioactive waste at a commercial LLW burial site operated by U.S. Ecology near Richland, Washington.

After retreatment, the water would be pumped from storage tanks to one of two evaporator condensate test tanks to be mixed to assure homogeneity and sampled to verify the concentration of contaminants. The water would then be pumped to the mechanical draft cooling tower letdown lines where it would be discharged to the river. The rate of release would be controlled to assure a continuous boron release of 25 ppm or less. To reduce the boron concentration below 25 ppm would require a dilution factor of at least 120. The concentrations of cesium, strontium, and tritium will be reduced by a factor of 120 from the concentrations shown for re-treated water in Table 2.2 (Achievable Quantity and Concentration columns). The cooling tower would provide a diluent flow of about 22,000 gal/min (83,000 L/min) to the accident-generated water discharge.

3.4.1.2 Environmental Impacts

The downstream population would be exposed to the accident-generated water in a highly diluted form through the drinking water treatment plant influent, direct exposure, and the consumption of fish and shellfish. The accident-generated water would have been diluted so that the average tritium concentration at the nearest downstream water intake would be approximately 11 to 17 pCi/L, depending on the rate (or duration) of discharge. This would be

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in addition to the 178 pCi/L tritium naturally found in the river water. [This dilution is approximately the same as 1 drop (0.05 ml) in 9 gallons (36 liters) of water.]

Occupational Radiation Exposure. The occupational radiation exposure required for completion of this alternative is primarily derived from the retreatment of the accident-generated water, about 2 to 5 person-rem. Additional dose would be received during operation of the pumping controls, sampling and analysis of each tank, and routine verification of system performance. The dose from the water would be negligible but other sources at the site would contribute approximately 0.5 to 2 person-rem. This results in a total estimate of 2.5 to 7 person-rem for this alternative.

Radiation Exposure to the Public. The maximally exposed individual could receive a 50-year dose commitment of approximately 0.4 mrem to the bone and 0.06 mrem to the total body. The maximally exposed individual is a person who consumes Susquehanna River water and fish and participates in rivershore activities including bathing and swimming. In addition, consumption of shellfish from Chesapeake Bay at a maximum rate of shellfish consumption for the mid-Atlantic region, 97 lb/yr or 44 kg/yr (Rupp, Miller and Baes 1980) is assumed. Shellfish consumption contributes approximately 0.03 mrem to the bone and 0.002 mrem to the total body. The time period of the discharge would not materially affect the total dose received, but would affect the rate at which the dose was received.

The total 50-year dose commitment to the population that uses Susquehanna River water, and consumes drinking water and fish from the river and consumes shellfish from Chesapeake Bay, from the discharge of the water is estimated to be 3 person-rem to the bone and 0.3 person-rem to the total body. Shellfish consumption is estimated to be 11 person-rem to the bone and 0.9 person-rem to the total body. The total population dose received would not be materially affected by the time period over which the discharge occurred with the exception of the dilution effect of higher than normal river flows.

Commitment of Resources. No permanent land commitment is anticipated although approximately 10,000 ft^3 (282 m^3) of burial space would be required at the commercial LLW burial site operated by U.S. Ecology near Richland, Washington for the resin liners from re-treating the accident-generated water. This alternative, retreatment of the accident-generated water and long-term discharge to the Susquehanna River, is estimated to cost from $2.9 to 3.6 million. This cost is broken down in Table 3.12.

3.4.1.3 Accident Analysis

The potential accidents that have been considered for this alternative are the discharge of batches of the accident-generated water prior to retreatment as well as transportation accidents during the shipment of the resin liners to the commercial LLW burial site.

TABLE 3.12. Cost Breakdown for Long-Term River Discharge

Tasks	Cost, $ millions
Retreatment of water (includes transportation and burial of resin liners)	2.3
System modifications and instrumentation	0.5 to 1.0
Operating costs (2 years)	0.1 to 0.3
TOTAL	2.9 to 3.6

The discharge of a batch of accident-generated water prior to retreatment is highly unlikely; however, the release of water from a storage tank containing approximately 11,000 gallons (42,000 liters) would result in the doses discussed in Section 3.1.1.3.

Accidents occurring during the shipment of resin liners to the LLW disposal site are addressed in Section 3.1.2.3.

3.4.1.4 Regulatory Considerations

Both the NRC and the PaDER approval would be required for this disposal option. The EPA requirements of 10 CFR 141 and 190, as discussed in Section 2.3.1, must be met. The 10 CFR 20 Appendix B limits for radioisotope concentrations in air and water above background in unrestricted areas apply (see Table 2.5) as do the station technical specification limits. The NDPES permit issued September 19, 1986, and discussed in Section 2.3.4 restricts the pH of liquid discharges to between 6.0 and 9.0 and requires the PaDER approval prior to discharge of boron.

3.4.2 Short-Term River Discharge

In this alternative, the accident-generated water would be re-treated to reduce the radionuclide concentrations as in the previous alternative. It would then be discharged to the Susquehanna River as rapidly as possible. At least 30 hours would be required to reduce boron levels to 25 ppm (presumed maximum discharge concentration allowed by PaDER) with the maximum dilution obtainable using equipment presently available at TMI. Initially it was presumed that downstream water intakes could be closed during the short duration of accident-generated water passage. However, there are several impoundments that would hold up and mix the water so that some accident water would remain in the vicinity of river intakes for several weeks. There might be, however, some reduction in radiation dose to the population if the release were timed to coincide with high water flows. A flow rate of 34,000 cfs, the annual average was assumed in calculations. Greater flows would reduce the population dose proportionately.

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3.4.2.1 System Description and Operation

The total inventory of the accident-generated water would be re-treated by the SDS and/or the EPICOR II water purification system prior to initiating river discharge to further reduce the radionuclide concentrations. The types and quantities of contaminants expected to remain in the water are given in Table 2.2 (in the Achievable Quantity and Concentration columns). The tritium and borate concentrations would remain essentially unchanged. Retreatment would generate an additional 61 resin liners (approximately 10,000 ft^3, or 283 m) to be disposed of at the commercial LLW burial site operated by U.S. Ecology near Richland, Washington.

After retreatment, the accident-generated water would be sampled and analyzed to determine the concentrations remaining. The re-treated accident-generated water would be pumped to the mechanical draft cooling tower discharge where water dilution would be added. Typical service water cooling tower blowdown flow is about 22,000 gal/min (83,000 L/min). The rate of discharge of the re-treated accident-generated water would be controlled such that the radionuclide concentrations at the point of discharge would be below the permissible release concentrations given in 10 CFR 20, Appendix B, Table 2, column 2, and plant technical specifications.

To reduce the boron concentration to 25 ppm would require a dilution factor of 120, and a maximum discharge rate of 1,100 gal/min (4,000 L/min). The concentration of cesium, strontium, and tritium would also be reduced by a factor of 120. An increase in the dilution flow to about 140,000 gal/min (530,000 L/min) could be implemented, with minor modifications to existing equipment and changes in the technical specifications. At this rate of dilution flow, the rapid discharge of water to the river could occur over a shorter period of time and maintain the release concentrations within the limits.

3.4.2.2 Environmental Impacts

The downstream population would be exposed to the water in a highly diluted form through the drinking water treatment plant influent, direct exposure, and the consumption of fish and shellfish. The maximum tritium concentration at the nearest downstream water intake would be approximately 75 pCi/L from the accident-generated water, assuming a river flow of at least 34,000 ft^3/sec. This is in addition to the approximately 178 pCi/L naturally found in the river water. [This dilution is approximately the same as 1 fluid ounce (29 milliliters) in the 9 gallons (36 liters) discussed for the previous alternative.]

Occupational Radiation Exposure. The occupational radiation exposure required for the completion of this alternative is primarily derived from the retreatment of the accident water, about 2 to 5 person-rem. Additional dose would be received during operation of the pumping controls, sampling and analysis of each tank, and routine verification of system performance. The dose from the water would be negligible but other sources at the site would

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contribute approximately 0.5 to 1 person-rem. This results in an estimate of 2.5 to 6 person-rem for the entire process.

Radiation Exposure to the Public. Ingestion of contaminants from the accident-generated water by use of the Susquehanna River water and consumption of drinking water and fish from the river and shellfish from Chesapeake Bay would result in a 50-year dose commitment of 0.4 mrem to the bone and 0.06 mrem to the total body of the maximally exposed individual (described in Section 3.4.1.2 for long-term river discharge). Shellfish consumption contributes approximately 0.03 mrem to the bone and 0.002 mrem to the total body [assuming consumption of shellfish from the Chesapeake Bay at a maximum rate of 97 lb/yr (44 kg/yr) for the mid-Atlantic region (Rupp, Miller and Baes 1980)].

The 50-year dose commitment for the total population from short-term discharge of accident-generated water is the same as given in Section 3.4.1.2. The duration of the discharge does not materially affect the total population dose received. The population that uses the Susquehanna River water, consumes drinking water and fish from the river and consumes shellfish from the Chesapeake Bay would receive 14 person-rem to the bone and 1.0 person-rem to the total body. Shellfish consumption contributes 11 person-rem to the bone and 0.9 person-rem to the total body.

Commitment of Resources. No permanent land commitment is anticipated although an additional 10,000 ft^3 (283 m^3) of burial space is required at the commercial LLW burial site operated by U.S. Ecology near Richland, Washington for the resin liners from re-treating the accident-generated water.

This alternative is estimated to cost from $2.8 to 3.3 million. The cost is broken down in Table 3.13.

TABLE 3.13. Cost Breakdown for a Short-Term River Discharge

Tasks	Cost, $ millions
Retreatment of water (includes transportation and burial of resin liners)	2.3
System modifications, instruments, and operating costs and monitoring	0.5 to 1.0
TOTAL	2.8 to 3.3

3.4.2.3 Accident Analysis

Discharge in a short period of time is the maximum accident for several other alternatives. It is doubtful that any accident would increase offsite doses or consequences beyond that predicted for a rapid release of the accident-generated water. The only exception would be the discharge of a

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batch of accident-generated water prior to retreatment. This scenario is unlikely, but is addressed in Section 3.1.1.3.

Accidents resulting from the transport of the resin liners to the commercial LLW burial site operated by U.S. Ecology near Richland, Washington are discussed in Section 3.1.2.3.

3.4.2.4 Regulatory Considerations

Both the NRC and the PaDER approval would be required for this disposal option. The EPA requirements of 40 CFR 141 and 190, as discussed in Section 2.3.1, must be met. The 10 CFR 20 Appendix B limits for radioisotope concentrations in air and water above background in unrestricted area (see Table 2.5) and the plant technical specifications apply. The NDPES permit issued September 19, 1986 and discussed in Section 2.3.4 restricts the pH of liquid discharges to between 6.0 and 9.0 and requires the PaDER approval prior to discharge of boron.

3.5 ALTERNATIVES INVOLVING ONSITE STORAGE

Maintaining the accident-generated water onsite through storage as a bulk liquid and burial as a solid were considered. The solidification of the accident-generated water and disposal onsite was discussed in Section 3.3. Onsite maintenance as a liquid is evaluated further in this section.

3.5.1 Liquid Storage in Tanks

This alternative is the no-action alternative. The liquid waste would be maintained in tanks onsite for an indefinite period of time. The accident-generated water has been maintained in tanks onsite since its initial removal and processing following the accident in 1979. Water volumes, tank integrity, and water quality have been monitored by the licensee and have been routinely monitored by the NRC staff as well.

Tritium is the only isotope that would be significantly reduced during a prolonged storage period. The reduction of the approximately 0.13 μCi/mL of tritium to a level comparable to the EPA limit for drinking water, 0.00002 μCi/mL, via radioactive decay would take approximately 150 years (neglecting isotopic exchange, evaporation, and dilution mechanisms). Additional treatment would be necessary to reduce the levels of cesium, strontium, and carbon. Because tanks have a finite life, construction of new tanks and transfer to them would be required if the storage period were sufficiently long.

3.5.1.1 System Description and Operation

The entire inventory of accident-generated water would be retained in existing and new storage tanks at TMI. Additional tankage for approximately 600,000 gallons of accident-generated water would be required. Routine

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surveillance and monitoring of the tanks would be required. Monitoring could be included in the continuing surveillance programs for the TMI site. The tanks would be vented to the atmosphere and a slow rate of evaporation and/or exchange would occur. The tanks would not absorb the radioactivity. Eventually, the tanks would need to be replaced or the water otherwise disposed of to prevent release from tank deterioration.

3.5.1.2 Environmental Impacts

Except for a small commitment of financial resources and a very small land commitment, environmental impacts of this alternative arise only at the time of water disposal or in the event of tank failure. Because the water contains relatively long-lived radiological contaminants, the environmental impacts from ultimate disposal are not expected to be significantly different from those impacts estimated for near-term disposal options.

Occupational Radiation Exposure. Construction of tanks and continuing surveillance of the water tanks are not expected to contribute significant additional occupational radiation exposure.

Radiation Exposure to the Public. Since the accident-generated water is expected to remain onsite, there are no significant exposure pathways to the public other than accidents.

Commitment of Resources. Only a small additional land commitment at TMI is anticipated for new tank construction. This alternative is estimated to cost from $0.1 to 1.3 million. The cost is broken down in Table 3.14.

TABLE 3.14. Cost Breakdown for Liquid Storage in Tanks

Tasks	Cost, $ millions
Construction of additional tanks	0.1
Monitoring and surveillance	0 to 0.2
Tank replacement	0 to 1.0
TOTAL	0.1 to 1.3

3.5.1.3 Accident Analysis

The only credible accident identified for this alternative is tank rupture, which in the worst case could result in discharge of the entire tank contents in a short period of time. Tank rupture and accidental discharge of the water are possibilities before the 150-year period required for decay to background levels without continued maintenance or tank replacement. The population dose would be very slightly less than that anticipated for prompt discharge of all accident-generated water prior to retreatment (because of the radioactive decay). The prompt accidental discharge of 2.3 million gallons (8.7 million liters) of this water would result in a bone dose of 3 mrem and a total body dose of 0.4 mrem for the maximally exposed individual, assuming that individual ingests water and fish from the Susquehanna River and participates in recreational activities such as swimming and boating. In addition, the maximally exposed individual is assumed to consume shellfish from Chesapeake Bay at the maximum rate of 97 lb/yr (44 kg/yr) for the mid-Atlantic region (Rupp, Miller and Baes 1980). Shellfish consumption would contribute approximately 0.2 mrem to the bone and 0.007 mrem to the total body.

The collective 50-year dose commitment to the population is estimated to be 40 person-rem to the bone and 1.0 person-rem to the total body from ingestion of drinking water and fish from the river, participation in recreational activities, and consumption of shellfish from the Chesapeake Bay. The total 50-year dose commitment to the larger population would contribute 100 person-rem to the bone and 3 person-rem to the total body. These doses would be lower after some radioactive decay.

3.5.1.4 Regulatory Considerations

No regulatory impediments are anticipated prior to termination of the license. However, this alternative is inconsistent with the Commission's policy that the cleanup, including the removal of radioactive waste from the TMI site, be carried out safety and expeditiously. In the absence of overriding benefit associated with storing disposable radioactive waste onsite, the NRC staff has continued to support safe and expeditious removal. Ultimate disposition of the water would be required prior to facility decommissioning and termination of the TMI-2 license.

3.6 ALTERNATIVES CONSIDERED BUT REJECTED

Several alternatives for disposal of the accident-generated water were considered but were eliminated from further evaluation as being less desirable from a technical standpoint or clearly inferior to other alternatives receiving more detailed consideration. The bases for these findings included insufficiently developed technology, lack of cost effectiveness, and regulatory and institutional issues not expected to be resolved in a reasonable period of time. These alternatives are briefly described here along with the basis for their rejection.

3.6.1 Ocean Disposal

Ocean disposal either as a bulk liquid or as a solidified packaged solid (concreted in drums) was considered. This alternative is expected to result in insignificant environmental impacts. However, EPA approval under the provisions of 40 CFR Subchapter H would be required. EPA has not yet established the requirements for applications under this provision and is in the process of doing so. Following EPA approval, a joint resolution of both houses of Congress would be required within 90 days.

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A resolution of the London Dumping Convention (IMO 1985) establishes a moratorium on ocean disposal of radioactive waste; however, this resolution is not binding even though the United States is a signatory to the convention. It is expected that members of Congress would be concerned, however, should the United States institute ocean dumping because other countries that have honored the agreement might resume ocean dumping and include waste containing much more hazardous radionuclides than the TMI accident-generated water.

As a result of the uncertain and protracted approval process likely to be associated with this alternative, it was rejected.

3.6.2 Pond Evaporation Onsite

Pond evaporation onsite was considered, but was rejected for two reasons. First, onsite ponds would collect rain water at approximately the same rate as water would evaporate; therefore, although the tritium would be released to the atmosphere, the total volume of water to be disposed of would not decrease. This drawback might be overcome by the addition of heaters or spray systems to the ponds. However, if this equipment were installed to enhance evaporation, the occupational exposure to tritium would be the highest of any alternative considered, and no significant advantages over a commercial low-level liquid waste evaporator were identified.

3.6.3 Onsite Cooling Tower Evaporation and Bottoms Disposal to the River

Onsite evaporation in a forced draft cooling tower with the cooling tower blowdown going to the river was considered in the PEIS (NRC 1981) and reevaluated briefly. To implement this alternative, the accident-generated water would be re-treated, and diluted before being fed to the forced draft cooling tower. Approximately 90% of the tritium and 20 to 30% of the cesium, strontium, and boron would be released to the atmosphere. The tritium would be released primarily in water vapor. The cesium, strontium, and boron would be dissolved in water and released in fine water droplets and particulates. The larger droplets would deposit in the immediate vicinity and smaller droplets and particulates would be dispersed over a wider range. The remaining 70 to 80% of cesium, strontium, and boron, as well as the remaining tritium, would be released to the Susquehanna River in the cooling tower blowdown.

This alternative was rejected for the following reasons: the cesium and strontium release to the atmosphere would be 20 to 30 times the amount released using a commercial LLW evaporator; there would likely be areas, at least onsite, where boron deposition would inhibit vegetation growth for some time; the onsite radionuclide concentrations in the vicinity of the cooling tower would be higher than with other alternatives; and river releases are not eliminated, but merely reduced relative to river disposal of the bulk water.

3.6.4 Distillation and Solidification of the Distillate

Alternatives involving closed cycle evaporation were not considered in the draft supplement but were added to the final as a result of comments

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received. Distillation (closed cycle evaporation) of the accident-generated water, as discussed in Section 3.1.3, is a more effective means of particulate radionuclide removal than reprocessing by the SDS and EPICOR II system. The alternative of using distillation instead of SDS and EPICOR II pretreatment prior to onsite disposal as a solidified solid (as discussed in Section 3.3.1) was considered. However, since the amount of radioactive material in the water following either SDS/EPICOR reprocessing or evaporation is relatively small, the environmental impacts of solidification/onsite disposal following either procedure would not be significantly different. Thus, except for the relatively higher cost associated with evaporation versus SDS/EPICOR reprocessing (i.e., $6.2 to 12 million versus approximately $2.3 million), the environmental impacts of this alternative are similar to those already presented in Section 3.3.1.2 and no further consideration has been given this alternative.

3.6.5 Distillation Followed by Open Cycle Evaporation

The alternative of distillation followed by disposal by open cycle evaporation was considered and rejected. Not less than 99.9% of the cesium, strontium, and carbonate would be retained in the bottoms from either open or closed cycle evaporation. Reducing particulates to 0.0001% of their initial quantity while leaving the concentration of tritium (and iodine if present) unaffected does not warrant the additional cost.

3.6.6 Deep-Well Injection at Three Mile Island

Deep-well injection on the TMI site would require an extensive investigation of the underlying strata to ensure that the requirements of 40 CFR Subchapter D are met (40 CFR 144). The likelihood of finding suitable hydrogeologic conditions is considered small. Following the investigations, state and EPA approval would be required before starting well construction. This alternative for disposal is estimated to require at least five years. There is a high probability that it would not gain approval. The injection site would become a candidate site under the Comprehensive Environmental Response, Compensation, and Liability Act.

3.6.7 Deep-Well Injection at the Nevada Test Site

Truck shipment to the Nevada Test Site followed by disposal into one of the weapons test cavities was originally considered a feasible alternative, and the impact analysis presented in the draft supplement remains valid. A letter received from the Assistant Secretary for Environment, Safety, and Health (Appendix A, comment letter 18) has led the staff to reject the alternative as unfeasible because "DOE policy, embodied in Order 5820.2..., states that disposal operations involving discharges of liquid low-level waste (LLW) directly to the environment or on natural soil columns shall be replaced by other techniques...." Also, disposal of the water in the test cavity would make the site a potential site under the Comprehensive Environmental Response, Compensation, and Liability Act.

3.6.8 Crib Disposal at Hanford

Truck shipment to the Hanford Nuclear Reservation near Richland, Washington followed by disposal into an existing in-ground structure for the disposal of low-level radioactive waste (crib) was originally considered a feasible alternative, and the impact analysis presented in the draft supplement remains valid. A letter received from the Assistant Secretary, Environment, Safety, and Health (Appendix A, Letter 18) has led the staff to reject the alternative as infeasible because the use of cribs for this purpose is not in compliance with DOE Order 5820.2, and because their use for disposal of the water would make the site a potential site under the Comprehensive Environmental Response, Compensation, and Liability Act.

3.6.9 Disposal at the Oak Ridge National Laboratory Hydrofracturing Facility

Disposal of the accident-generated water at the Oak Ridge National Laboratory (ORNL) hydrofracturing facility involves transporting the bulk accident-generated water to ORNL where it would be mixed with grout and injected into the ground under sufficient pressure to fracture the strata. The mixture would then harden to fix the water in a solid sheet in the strata. Additional facilities at ORNL and the approval of DOE would be required. The estimated seven-year-disposal time and the fact that the cost would not be less than the cost of trucking the accident-generated water were the reasons that precluded further consideration of this alternative.

3.6.10 Reuse

Disposing of the accident-generated water (either in its present form or as a residue following evaporation) by reuse in other reactors or facilities was considered and found to be impractical. The licensee's proposal indicated that accident-generated water, especially if concentrated by evaporation, contains impurities (e.g. river silt, corrosion products, sulfates, phosphates, carbonates, and biological debris) that are not acceptable for use in reactor cooling systems.

For use in other reactors, the accident-generated water would be commingled with RCS liquids, collected as normal plant letdown, processed through plant radwaste systems, and released to the host plant liquid waste discharge system. The TMI reactors, other commercial reactors, and DOE reactors were considered for the reuse alternative.

Disposal through reuse at TMI-1 would involve the consumption of approximately 300 gallons (1,100 liters) of accident-generated water per day and would require 19 years for disposal. The 19-year disposal period is not desirable; but the alternative was rejected primarily because it has no advantages over other alternatives that result in release to the Susquehanna River.

Reuse at other reactors would require an agreement among utilities to accept the accident-generated water and discharge it at their sites. A wide

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range of regulatory and institutional issues would need to be resolved and, because reactor coolants are purified by ion exchange, the ultimate environmental release would not be appreciably lower than for other alternatives involving discharge to the environment.

Disposal by reuse at DOE facilities is not practical. The accident-generated water is unsuitable for use in DOE reactors because of the borate concentration, and reuse at other types of DOE facilities did not appear advantageous.

3.6.11 Land Spraying at the Nevada Test Site

Land spraying at NTS was considered in addition to pond evaporation (Section 3.2.1) and deep-well injection (Section 3.6.7). Transportation considerations are, of course, the same. Additional storage capacity at the NTS would be required because spraying would only be done during favorable climatic conditions. The borate and boric acid salts containing cesium and strontium would remain on the surface, where they could become airborne. In addition, land spraying has no identified advantages over deep-well injection or pond evaporation at the NTS.

3.6.12 Combined Catalytic Exchange Treatment

Methods to remove the tritium from water were investigated. In a method called the combined catalytic exchange treatment, electrolysis is used to produce hydrogen and oxygen gas from the accident-generated water. The oxygen gas is vented off and the hydrogen gas, which contains the tritium from the original water, is put in contact with the bulk solution. Under these circumstances the liquid phase becomes enriched in tritium and the gas phase becomes depleted in tritium. The gas then may be released. The liquid phase would still require disposal.

Application of this technology to the accident-generated water would require a significant, costly research and development effort because the method has never been implemented on such a large scale and never in the presence of boric acid. Moreover, the partitioning of tritium is incomplete and a relatively large tritium-enriched liquid waste would remain from such an effort. The alternative was therefore rejected in favor of the proven and less costly technology of the other alternatives.

3.6.13 Water Distillation Treatment

Another method for removing tritium from water is by distillation. Distillation columns, in conjunction with catalytic exchange, have been used to produce relatively pure tritiated water and tritium-depleted water. The technique has proven effective in reducing water containing 3 Ci/kg of tritium to 1 Ci/kg of tritium; however, data are not available to indicate that it would be effective in further reducing the tritium level from its approximately 0.00014 Ci/kg in the accident-generated water. This alternative was also rejected in favor of proven and less costly alternatives.

3.6.14 High-Altitude Disposal

The alternative of high-altitude disposal was rejected because shipping the bulk liquid to the Harrisburg International Airport, loading it in planes, and discharging into the very high atmosphere over the ocean would result in a population dose and a cost that would be considerably higher than other offsite disposal options.

3.6.15 Open Cycle Evaporation at Maxey Flats, Kentucky

Open cycle evaporation at the Maxey Flats Site was considered but rejected as probably unavailable. Maxey Flats is a low-level radioactive waste disposal site owned by the Commonwealth of Kentucky where commercial operations were terminated in 1977. The Commonwealth requires the site operator to manage the tritium-contaminated water that collects in the burial trenches. The water is collected, solids are removed, and the water is evaporated. Rickard and Kirby (1984) report that approximately 86 Ci/day of tritium (average of discharge from 1979 to 1984) are disposed of in this manner. The bottoms are stored for disposal. A primary goal of the operation is the completion of the water removal from the trenches and the termination of the evaporation process. Approval to transport the TMI-2 accident-generated water to Maxey Flats, commingle it with the trench water, and process it through the evaporator would involve the Commonwealth of Kentucky and would not have a high probability of approval. It would result in the release of tritium to the atmosphere both onsite and offsite just as other evaporation alternatives would. This alternative was rejected.

4.0 AFFECTED ENVIRONMENT

This section contains a brief description of the environment and population that may be affected by the proposed actions to dispose of the TMI-2 accident-generated water. This information has been taken primarily from the PEIS (NRC 1981). Population distribution estimates have been updated. Other sections have been reviewed and changes since the PEIS do not affect the environmental analysis.

Four areas that have the potential to be affected by the activities involved in disposition of the TMI-2 accident-generated water have been identified: the area in the vicinity of the facility, the area downstream including the Susquehanna River and the Chesapeake Bay, the transportation routes used for movement of materials to and from the site, and the offsite disposal locations.

The vicinity of the site is defined as the area within an approximate 12-mile (20-kilometer) radius of TMI. For the purposes of evaluating radiation doses from the disposal alternatives, the area within a 50-mile (80-kilometer) radius is considered. Figures 4.1 and 4.2 show the location of the site and its relationship to population centers and municipalities in the area. The total population in the 50-mile (80-kilometer) radius is estimated to be 2.2 million. Approximately 350,000 people live within a 12-mile (20-kilometer) radius of TMI. Figures 4.3 and 4.4 show the population distribution within a 12-mile (20-kilometer) and a 50-mile (80-kilometer) radius of TMI.

4.1 THE VICINITY OF THREE MILE ISLAND

The area is predominantly rural, and supports dairy, poultry, farming, and forestry operations. The soils in the vicinity, combined with favorable physiographic and climatological features, produce higher-than-average crop yields for the state.

In spite of the agricultural operations, the population density is relatively high, about 570 people per square mile (220 people per square kilometer). Several municipalities are located within the area; the largest city, 12 miles (20 kilometers) to the northwest, is Harrisburg with a population of about 53,000 (in 1980).

4.1.1 Climate

The area has a continental climate. In winter, the predominant air mass over the region is continental polar air somewhat moderated by the influences of the Appalachian Mountains and the Chesapeake and Delaware Bays. In summer, maritime tropical air masses originating over the Gulf of Mexico or the Caribbean Sea predominate.

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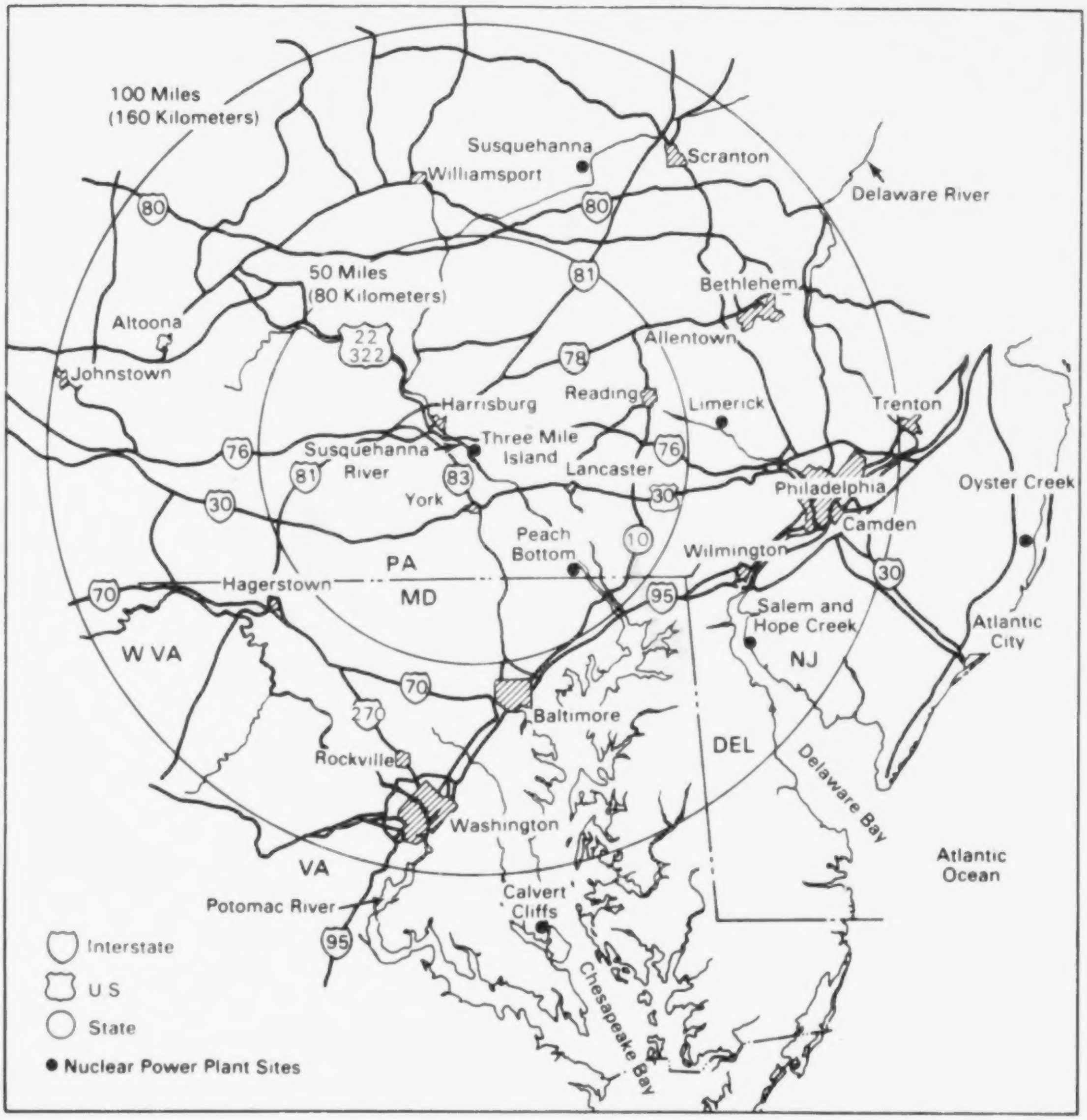

100 Miles
(160 Kilometers)
50 Miles
(80 Kilometers)
Susquehanna
Scranton
Williamsport
Delaware River
80
80
81
Bethlehem
Altoona
22
322
Allentown
Johnstown
78
Reading
Limerick
Trenton
Harrisburg
Three Mile Island
Susquehanna River
76
76
81
83
Lancaster
York
30
30
Philadelphia
Oyster Creek
Camden
Peach Bottom
10
Wilmington
PA
MD
70
Hagerstown
95
30
Salem and Hope Creek
Atlantic City
W VA
NJ
70
270
Baltimore
DEL
Delaware Bay
Rockville
Washington
Atlantic Ocean
VA
Calvert Cliffs
Potomac River
95
Chesapeake Bay
Interstate
U S
State
● Nuclear Power Plant Sites

FIGURE 4.1. Map of the Area Within a 100-Mile (160-Kilometer) Radius of the Three Mile Island Site

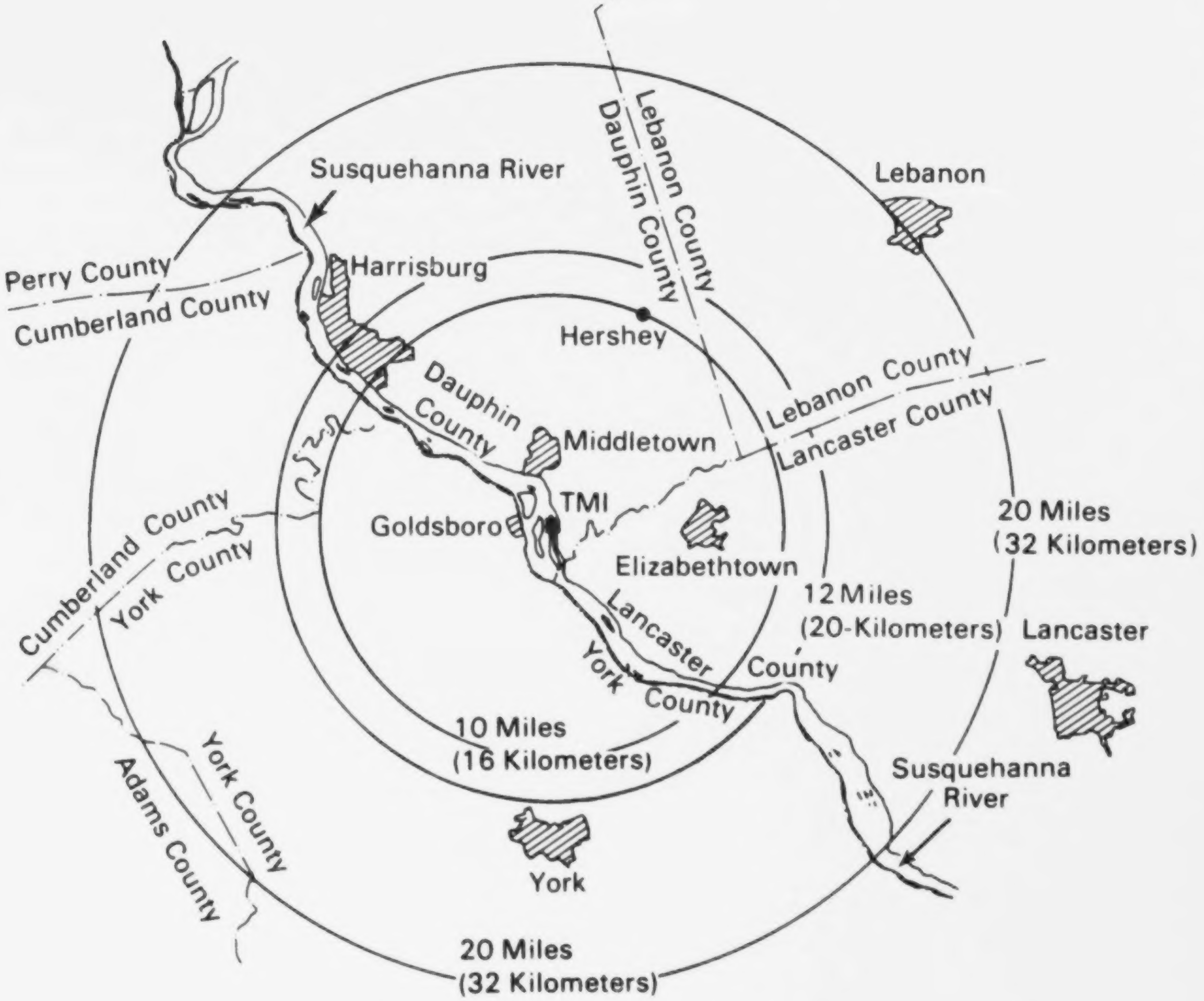

Susquehanna River
Lebanon
Lebanon County
Dauphin County
Perry County
Cumberland County
Harrisburg
Hershey
Dauphin County
Middletown
Lebanon County
Lancaster County
TMI
Goldsboro
Elizabethtown
20 Miles
(32 Kilometers)
Cumberland County
York County
12 Miles
(20-Kilometers)
Lancaster
Lancaster County
York County
Cumberland County
York County
10 Miles
(16 Kilometers)
Susquehanna River
York County
Adams County
York
20 Miles
(32 Kilometers)

FIGURE 4.2. Map of the Area Within a 20-Mile (32-Kilometer) Radius of the Three Mile Island Site

63

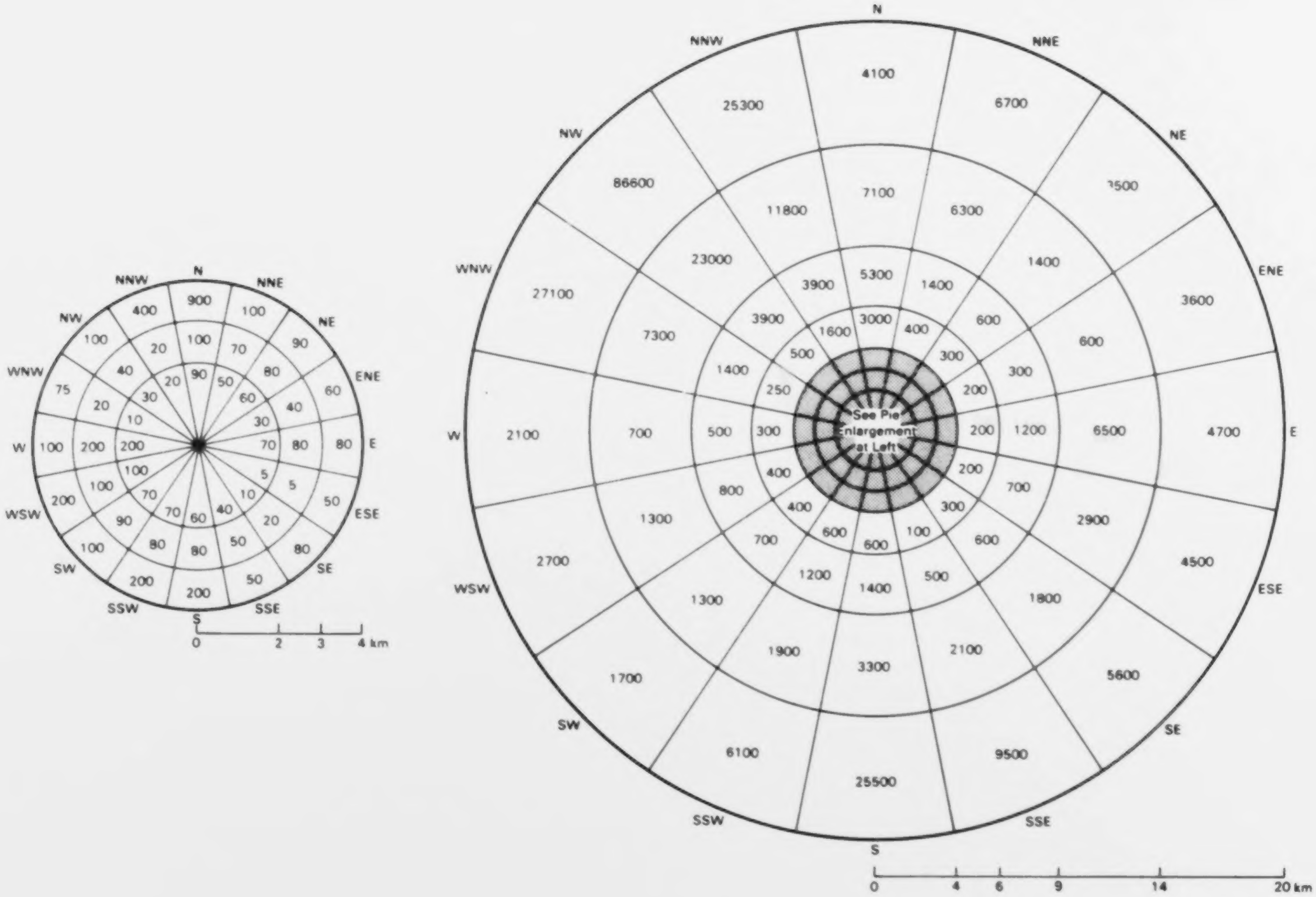


FIGURE 4.3. Population Distribution Within a 12-Mile (20-Kilometer) Radius of Three Mile Island (data from an internal NRC document prepared by the Site Analysis Branch of the Office of Nuclear Reactor Regulation, "1981 Residential Population Estimates 0-80 Kilometers For Nuclear Power Plants") 64

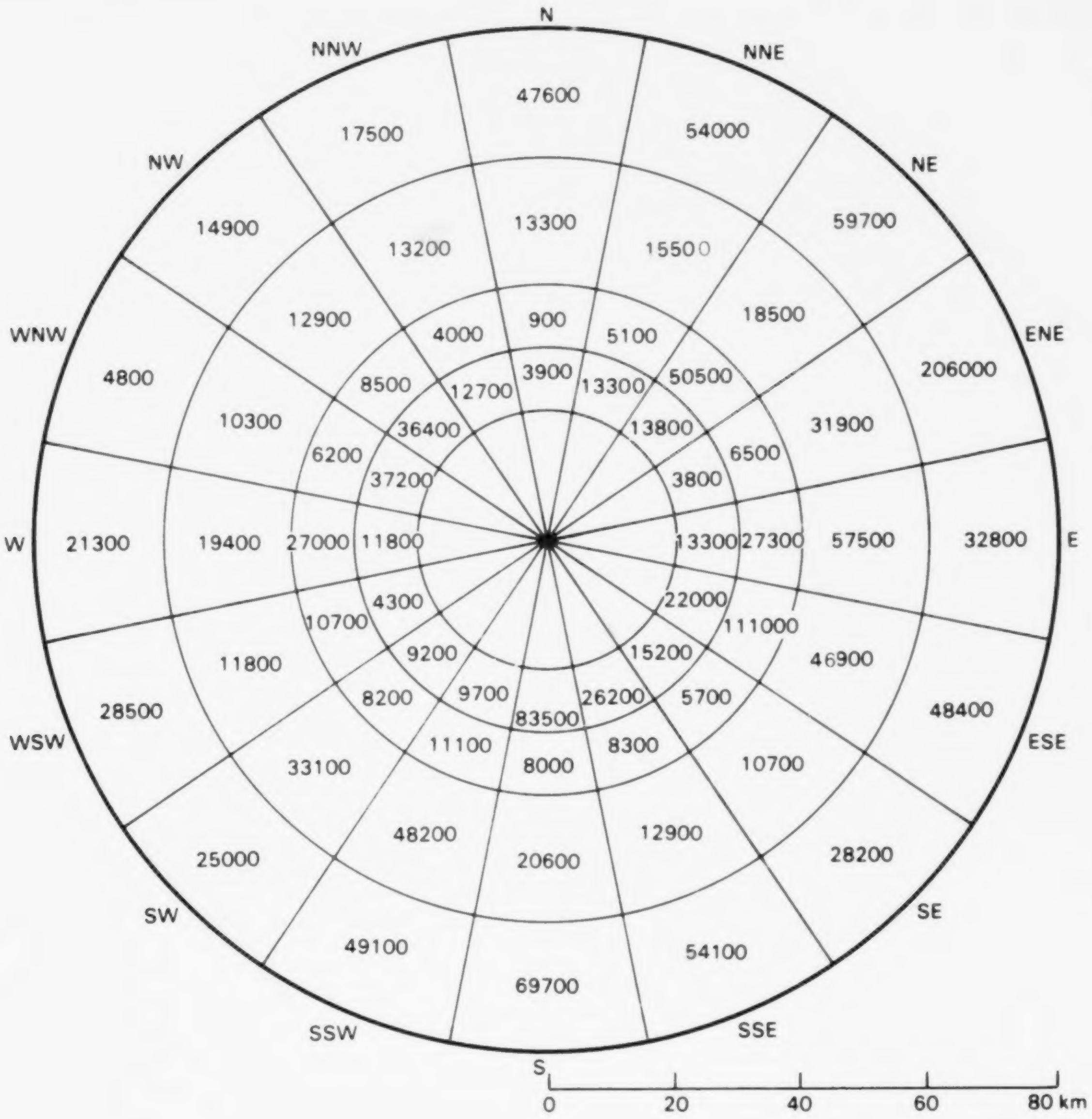

N
NNW
NNE
47600
17500
54000
NW
NE
14900
13300
13200
15500
59700
12900
4000
900
5100
18500
WNW
ENE
4800
8500
12700
3900
13300
50500
206000
10300
36400
13800
31900
6200
37200
3800
6500
W
21300
19400
27000
11800
13300
27300
57500
32800
E
10700
4300
22000
111000
11800
9200
15200
46900
28500
8200
9700
26200
5700
48400
WSW
83500
ESE
11100
8000
8300
33100
10700
48200
12900
25000
20600
28200
SW
SE
49100
54100
69700
SSW
SSE
S
0
20
40
60
80 km

FIGURE 4.4. Population Distribution Within a 50-Mile (80-Kilometer) Radius of Three Mile Island (data from an internal NRC document prepared by the Site Analysis Branch of the Office of Nuclear Reactor Regulation, "1981 Residential Population Estimates 0-80 Kilometers For Nuclear Power Plants")

Winters are relatively mild for the latitude; summers are warm and humid. While the extreme temperatures recorded for the area were 107°F (42°C) in July 1966 and -14°F (-26°C) in January 1912, temperatures of 90°F (32°C) or higher may be reached on only 20 to 25 days annually and temperatures of 0°F (-18°C) or lower may be expected 1 to 2 days annually. The predominant wind flow is from the northwest. Figure 4.5 shows the onsite wind data at the 100-ft (30-m) level.

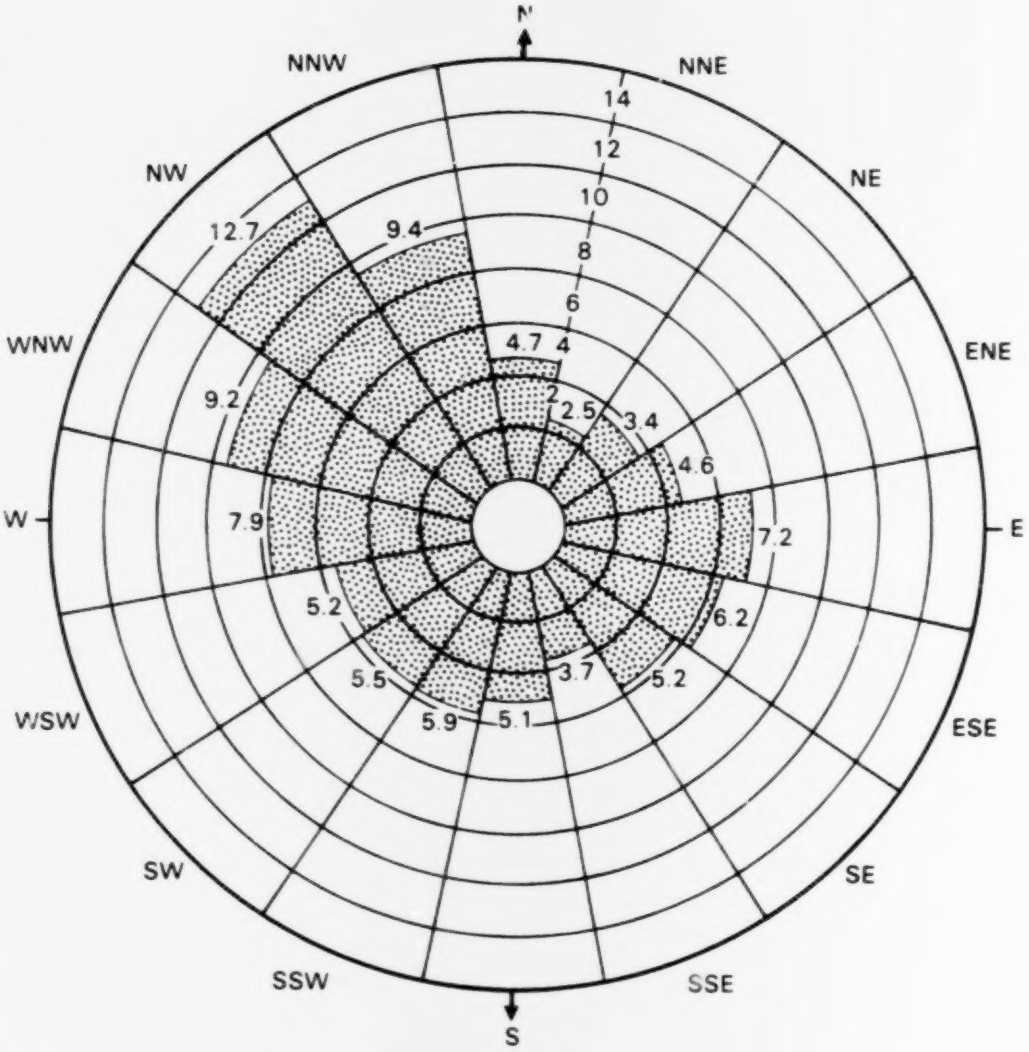
Annual total precipitation in this area is expected to exceed 40 inches (102 centimeters) including a normal average snowfall of 37 inches (94 centimeters). The average annual evaporation is within the range of 33 to 45 inches (84 to 114 centimeters), depending on the depth and configuration of water being evaporated. Consequently, significant net water loss to the atmosphere is not expected from closed ponds.

4.1.2 Surface Water

The TMI site is located in the Susquehanna River drainage basin which has a total drainage area of 27,510 square miles (7,125,090 hectares) where it enters the Chesapeake Bay. Recorded data beginning in 1890 indicate that the flow rate of the Susquehanna River is highly variable, ranging from a minimum flow of 1700 cfs (48,000 L/sec) in 1964 to a maximum flood of record of 1,020,000 cfs (29,000,000 L/sec) during spring flooding in 1972 (NRC 1976). Mean monthly flows for the period 1891 to 1979 ranged from 11,700 to 82,600 cfs (330,000 to 2,300,000 L/sec) with the low flow occurring in late summer and the high flows occurring in early spring. The average annual flowrate is 34,000 cfs (963,000 L/sec). Several dams and reservoirs are located on the Susquehanna River above and below TMI for flood control, low-flow augmentation, and power generation.

The surface water of the Susquehanna River downstream from Harrisburg is acceptable for all general uses, e.g., supporting aquatic life, recreation, and primary contact. The river is not an attractive source of public water supply because of occasional high sulfate levels and high amounts of wastewater-derived coliform bacteria. Presently, the river and the streams in the vicinity of TMI are used for both public and industrial water supplies, power generation, boating, sport fishing, and recreation. Sport fishing, but not commercial fishing, is done in all streams in the general area of the site. The nearest potable water user is five miles downstream at the Brunner Island steam-electric generating station. See Figure 4.6 for principal water users downstream of the TMI plant.

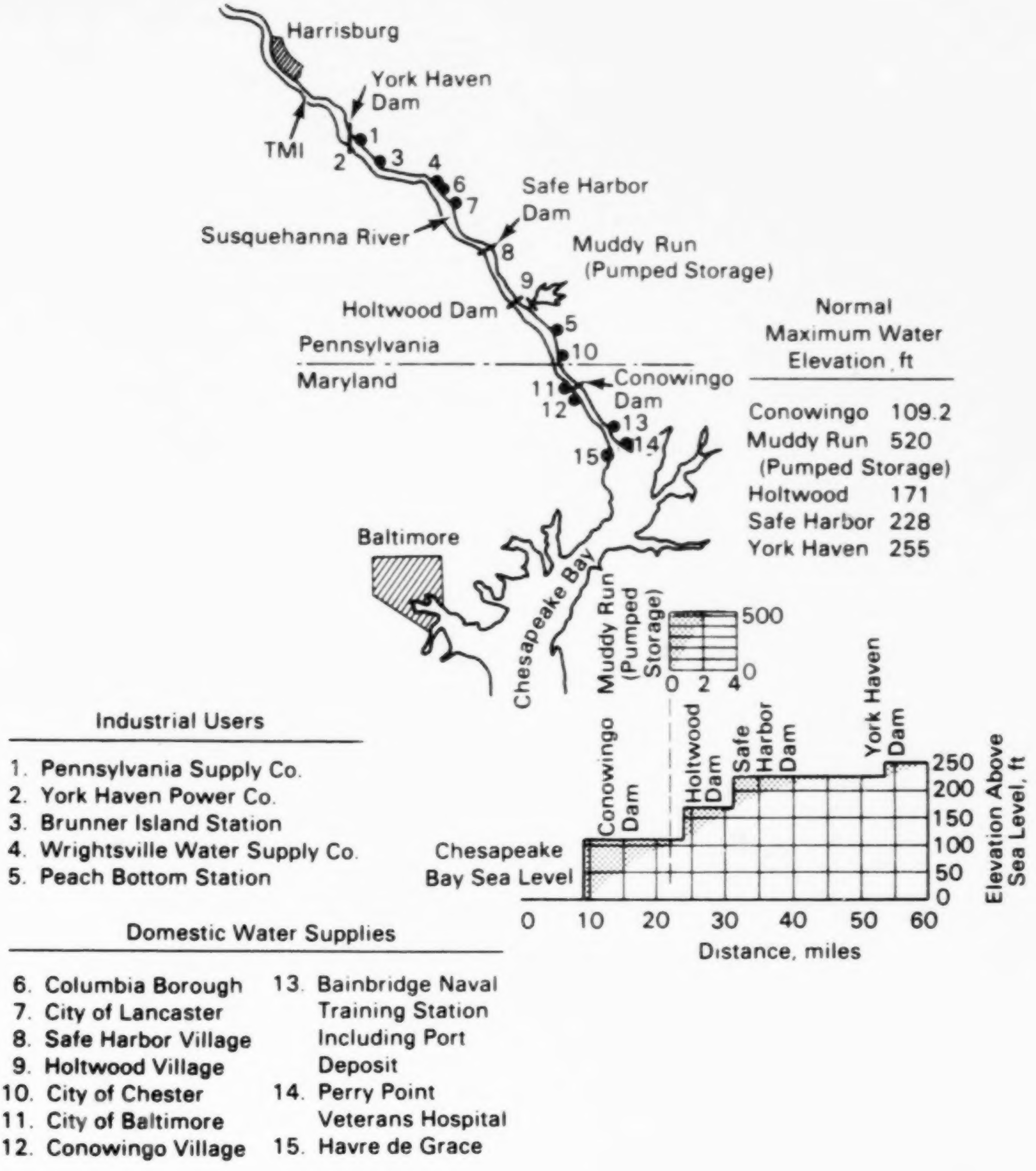
Specific water quality data can be found in the PEIS (NRC 1981). In general, the water is moderately high in total hardness, with high and variable sulfate and iron concentrations (often in excess of the state limit), a relatively low alkalinity, and a high fecal coliform count (also, often in excess of the state limit). These characteristics are largely attributable to drainage from old coal mines in the watershed and from domestic and agricultural wastes.



▨ Indicates Percent of Time Wind Blows From Direction Shown

FIGURE 4.5. Three Mile Island Annual Average Wind Direction at 100 Feet (1972 to 1975 data)

67


Harrisburg
York Haven Dam
TMI
Susquehanna River
Safe Harbor Dam
Muddy Run (Pumped Storage)
Holtwood Dam
Pennsylvania
Maryland
Conowingo Dam
Baltimore
Chesapeake Bay
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Muddy Run (Pumped Storage)
500
0
0 2 4
Conowingo Dam
Holtwood Dam
Safe Harbor Dam
York Haven Dam
Chesapeake Bay Sea Level
250
200
150
100
50
0
Elevation Above Sea Level, ft
0 10 20 30 40 50 60
Distance, miles

Normal Maximum Water Elevation, ft	
Conowingo	109.2
Muddy Run (Pumped Storage)	520
Holtwood	171
Safe Harbor	228
York Haven	255

Industrial Users

1. Pennsylvania Supply Co.
2. York Haven Power Co.
3. Brunner Island Station
4. Wrightsville Water Supply Co.
5. Peach Bottom Station

Domestic Water Supplies

6. Columbia Borough
7. City of Lancaster
8. Safe Harbor Village
9. Holtwood Village
10. City of Chester
11. City of Baltimore
12. Conowingo Village
13. Bainbridge Naval Training Station Including Port Deposit
14. Perry Point Veterans Hospital
15. Havre de Grace

FIGURE 4.6. Principal Water Users Along the Susquehanna River in the Vicinity of Three Mile Island

Radioactivity measurements of Susquehanna River water were made by the U.S. Geologic Survey prior to the TMI accident. The tritium concentration was measured during the 1977 water year and found to be fairly constant at 178 pCi/L. Dissolved and suspended gross beta activities were measured on November 8, 1976, and reported as follows:

Dissolved gross beta: 2.4 pCi/L as cesium-137
1.9 pCi/L as strontium-90/yttrium-90

Suspended gross beta: 0.4 pCi/L as cesium-137
<0.4 pCi/L as strontium-90/yttrium-90

Radium-226 was measured on the same date by the radon method as 0.08 pCi (alpha) per liter. Gross alpha activity on the same date is reported as:

Dissolved gross alpha: <1.6 µg/L as natural uranium (<1.08 pCi/L)

Suspended gross alpha: 0.7 µg/L as natural uranium (0.5 pCi/L)

A measurement of uranium concentration, presumably by the chemical (fluorimetric) method made on the same date gave a value of 0.06 µg/L. Defining a strictly natural background for fission products and tritium is difficult because of small but significant contributions (depending on the latitude) from nuclear testing. The contribution from the commercial nuclear fuel cycle is negligible. The radioactivity observed in the Susquehanna River at Harrisburg during 1977 was below the level regarded as normal for this latitude. For example, the average radioactivity levels in surface water in the Chicago area have been reported as: alpha, 0.1 to 3 pCi/L and beta, 5 to 10 pCi/L. The National Council on Radiation Protection and Measurements cites that an average tritium level in surface water for the north latitudes of 30 to 50 degrees is 287 pCi/L. Additional discussion of the radionuclides of concern in the proposed action is contained in Section 2.3.

4.1.3 Groundwater

The TMI site has a water table elevation of about 280 feet (85 meters) mean sea level (MSL), depending upon the Susquehanna River stage, which is normally at 277 feet (84 meters) MSL. Site borings and observation wells indicate that water table elevations vary about 5 feet (1.5 meters) from a high at the island's center to the shores. The water table gradient is about 0.006 toward the river. The nearest potable water supplies are three wells located on the east bank of the Susquehanna River, directly across from TMI. All of these wells have groundwater elevations above the river and above the groundwater level at TMI. Since they are upgradient, these wells are not likely to be affected by site activities.

The site is underlain by sandy silts, sands, gravels, weathered bedrock, and hard siltstone (Gettysburg Formation). The Gettysburg Formation has basic artesian characteristics in the site area. Groundwater flow is highly anisotropic along the strike direction, with specific capacities ranging from 0.33 to 15.0 gallons per minute per foot (1.2 to 57 liters per minute per meter) of drawdown. The leakage of groundwater from the Gettysburg Formation would be expected to be upward but would vary considerably with the degree of jointing and relationship to strike direction. Therefore, effluents released accidentally from the plant should not migrate into the Gettysburg Formation.

Eight monitoring wells and nine observation wells have been installed on the site. Groundwater quality has been monitored since the wells were installed in 1980.

4.2 ECOLOGY

The aquatic and terrestrial ecology of the site and downstream areas are summarized in the following sections.

4.2.1 Aquatic Ecology of the Site

The biota of the Susquehanna River includes organisms usually associated both with flowing waters and, because of the impoundments, with standing waters. A dominant source of primary production is algae. The algae production is representative of algal succession in a lake and indicates the importance of the impoundments in the trophic structure of the river. Zooplankton composition and abundance are variable; the dominant groups are rotifers, cladocerans, and copepods. Periodic large populations of rotifers also suggests excessive domestic waste loadings of the river. The most abundant benthic invertebrates are tubificid worms and insect larvae.

The fish community can be characterized as a warm-water assemblage, and is dominated by members of the minnow, perch, and sunfish families. The lower portion of the river (below the Conowingo Dam, Figure 4.6) receives spawning migrations of some anadromous species, primarily members of the herring family and striped bass. Sport fishing for crappie, bass, walleye, channel catfish, and sunfish is popular on the entire river.

Further downstream in the shallow waters of the upper Chesapeake Bay, aquatic macrophytes are present, and terrestrial plants such as cord grass and wild celery are quite productive, making the area an attractive food source for waterfowl.

The invertebrate fauna is diverse and includes a gradation from freshwater to marine types, depending on the salinity of the water and the bottom substrate in the Chesapeake Bay. Oysters, clams, and bluecrabs are important to the commercial fishing industry.

The fish fauna of the Chesapeake Bay also is diverse, and dominant species change with the season and migratory patterns. Commercial fishing in the bay is important to the surrounding states. The major species harvested from Maryland waters include menhaden and bluefish.

4.2.2 Terrestrial Ecology of the Site

The land use in the vicinity of TMI is primarily agricultural with a significant amount devoted to residential and urban development. The population density of 570 people per square mile (220 people per square kilometer) is substantially higher than the rest of the state as a whole. The urban development is concentrated around population centers and along major transportation corridors. Agriculture is diverse and includes the farming of field crops such as corn and wheat, as well as dairy, poultry, and livestock operations. The forested areas contain both hardwood and softwood trees. The plant community is less than 80 years old and consists of species that are common to this type of terrain.

In the TMI vicinity, 212 species of terrestrial vertebrates including birds, mammals, reptiles, and amphibians have been found. Small-game animals include the eastern cottontail rabbit and the gray squirrel. Mammalian predators include the longtail weasel and the red fox. The largest mammal found on the site is the white-tailed deer. Four species of upland game bird have been found onsite: ring-necked pheasant, American woodcock, mourning dove, and rock dove. Whistling swan, Canada goose, nine species of dabbling duck, seven species of diving duck, and three species of mergansers also have been reported. This sampling of species is typical of the fauna found downriver. Because the Susquehanna River is a major flyway, large numbers and many species of migratory and resident waterfowl nest and feed on the ponds and reservoirs along the river.

No federally protected animal species are known to occur on or in the vicinity of the TMI site. However, the site lies within the ranges of occurrence of three federally protected species: southern bald eagle, peregrine falcon, and Indiana bat. During periods of migration, it is possible that individuals of these species could visit the site, although no known sightings are on record. One federally protected plant species, the golden seal, is known from the TMI vicinity although not from Three Mile Island. The Commonwealth of Pennsylvania's List of Endangered and Threatened Species includes several animals in addition to those afforded federal protection that might pass through the TMI vicinity. They are the king rail, the osprey, and the black tern.

4.3 SUSQUEHANNA RIVER/CHESAPEAKE BAY AREA

The predominant features of the potential impact area are the Susquehanna River and the Chesapeake Bay. The 450-mile- (724-kilometer-) long Susquehanna is a major river in the eastern United States and supplies about 50 percent of the fresh water in the bay. Chesapeake Bay is one of the largest estuaries in the world, having a surface of about 4,400 square miles (1,139,600 hectares), a length of nearly 200 miles (320 kilometers), and more than 7,000 miles (11,000 kilometers) of shoreline. The Susquehanna River/Chesapeake Bay system supports commercial and recreational fishing, boating and supplies water for public and industrial use.

Sport fishing on the Chesapeake Bay is a popular activity involving both private and charter boats. The majority of the fishing is done by residents of Maryland, Washington, D.C., Delaware, Pennsylvania, and Virginia. Sport fishing is also popular in the Susquehanna River from the vicinity of TMI to Havre De Grace (see Figure 4.6). While the river primarily serves local residents, sizable numbers of fishermen from Maryland and Pennsylvania are attracted to the river. There is also a large and growing use of the area for water-oriented recreation, such as boating.

Shellfish and finfish that are harvested commercially from the Chesapeake Bay include bluecrabs, oysters, soft-shelled crabs, surf clams, sea scallops, menhadden, croaker, bluefish, and flounder. The shellfish and finfish harvest is marketed to the fresh and processing markets, wholesalers, restaurants, and individuals, from Montreal, Canada to Texas, and from Chicago to Los Angeles.

In addition to Chesapeake Bay's importance to commercial and sport fishing, the surrounding marshes and woodlands provide thousands of acres of natural habitat for a diversity of wildlife. This area is in the path of the Atlantic flyway and provides wintering and feeding grounds for migrating waterfowl. The waterfowl species that are attracted to the region in large numbers include Canada geese, ducks, whistling swans, other species of birds that require the wetlands for food and other habitat requirements, plus a variety of game birds. The wildlife resources of the area provide opportunities for hunting and trapping, and for nonconsumptive activities such as bird watching, nature walking, and nature photography.

4.4 TRANSPORTATION ROUTES

The vicinity of TMI is broadly delineated by five transportation routes that encompass an irregularly shaped area. Interstate 81, oriented northeast to southwest, passes through the area, forming a portion of the western boundary. Interstate 80 forms the northern boundary. The southern boundary is Interstate 70, extending east-west. The eastern boundary may be regarded as State Route 10, oriented north-south and about 50 miles east.

Interstate 76, the Pennsylvania Turnpike, passes through the area and connects Harrisburg with urban centers to the east and west. State Route 10 is not a high-volume road and, in conjunction with other roads, connects with Interstate 95. U.S. Route 30 is a high capacity road between Lancaster and York, passing east-west through the area on the south. Interstate 83, originating at Harrisburg, extends south to York and Baltimore. U.S. Route 22/322 passes from the area to the northwest.

Shipments from the TMI site routinely pass over Interstate Routes 283, 83, 81, and 80 before they leave the Commonwealth of Pennsylvania to the west. Interstate 76 is not normally used for west bound shipments because of tunnel restrictions. Interstate 81 is normally used for southbound shipments. Highway routes to possible LLW disposal sites are shown in Figure 4.7.

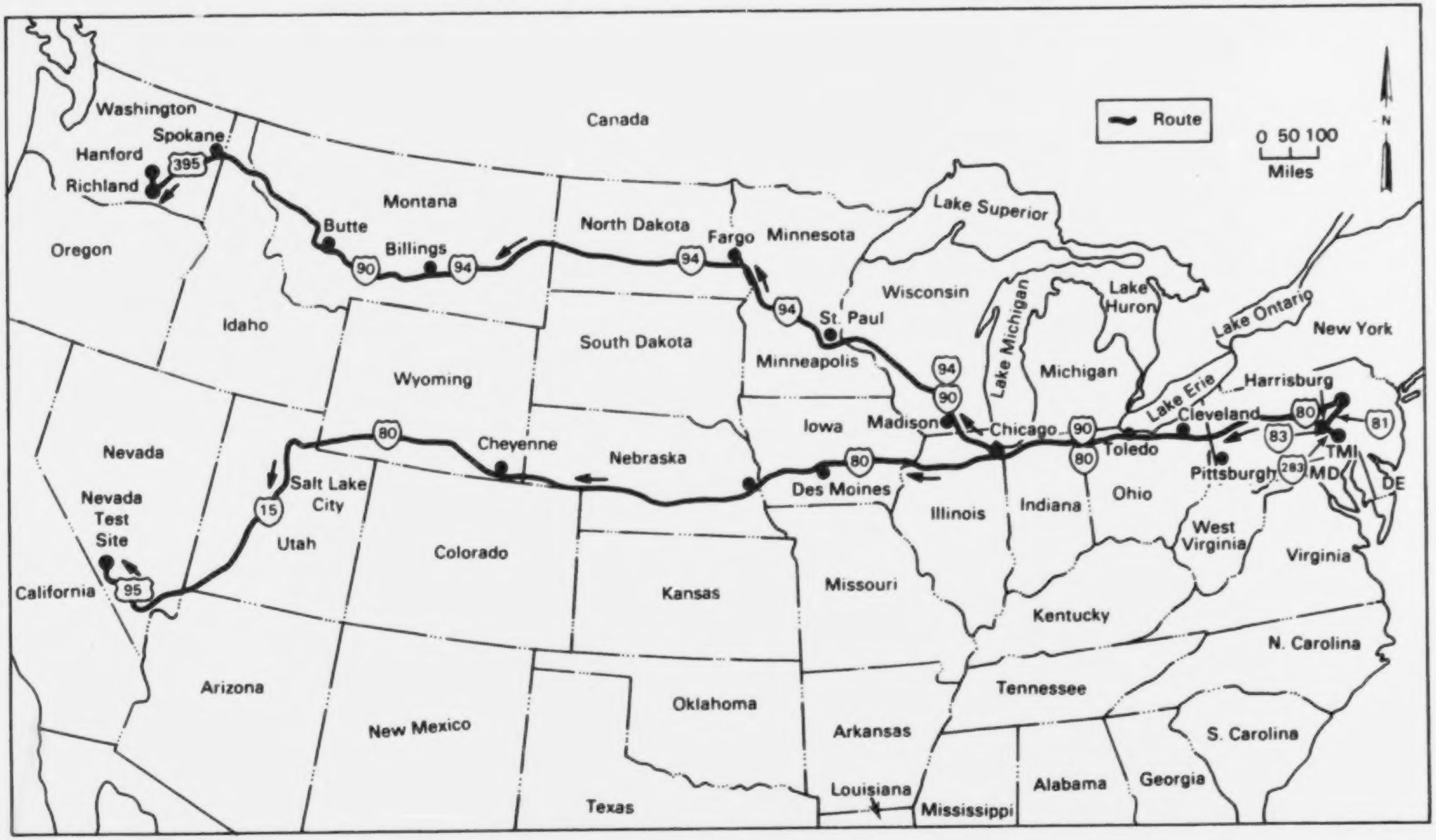

Route
0 50 100
Miles
N
Canada
Washington
Spokane
Hanford
Richland
395
Oregon
Montana
Butte
Billings
90
94
North Dakota
Fargo
Minnesota
Lake Superior
Wisconsin
St. Paul
Minneapolis
Lake Michigan
Michigan
Lake Huron
Lake Ontario
New York
Lake Erie
Harrisburg
Cleveland
80
81
83
TMI
MD
283
DE
Pittsburgh
Toledo
Ohio
Madison
Chicago
Indiana
Illinois
Iowa
Des Moines
Idaho
South Dakota
Wyoming
Nebraska
Cheyenne
Nevada
Nevada Test Site
Salt Lake City
15
Utah
Colorado
Kansas
Missouri
Kentucky
West Virginia
Virginia
95
California
Arizona
New Mexico
Oklahoma
Texas
Arkansas
Louisiana
Mississippi
Alabama
Georgia
Tennessee
N. Carolina
S. Carolina

FIGURE 4.7. Routes to Low-Level Waste Disposal Facilities from Three Mile Island

4.5 OFFSITE DISPOSAL LOCATIONS

Seven of the eight alternatives involve disposition of the accident-generated water, the solidified evaporator bottoms, or resin liners at offsite locations. The offsite locations potentially involved are the commercial LLW burial site near Richland, Washington and the NTS at Mercury, Nevada. Both of these are arid or semi-arid areas of relatively low population densities. Each of the sites is currently used for storage or disposal of radioactive waste materials.

4.5.1 Commercial Low-Level Waste Burial Site, Richland, Washington

The LLW burial site near Richland, Washington, is operated by U.S. Ecology, Inc. as a commercial radioactive waste disposal site. The facility is located 25 miles (40 kilometers) northwest of Richland, Washington, on 100 acres (40 hectares) of leased land near the center of the DOE Hanford Nuclear Reservation. The facility is licensed by the NRC for the disposal of commercial radioactive waste.

4.5.2 U.S. Department of Energy Nevada Test Site

The NTS is a limited access area of over 1,300 square miles (336,700 hectares) located in the southern Nevada. The site is controlled by the DOE and is used primarily for below-ground nuclear tests.

5.0 COMPARISON OF THE ENVIRONMENTAL IMPACT OF WATER DISPOSAL ALTERNATIVES

This section compares the alternatives for the disposal of the accident-generated water based on the environmental impacts described in Section 3.0. The impacts are summarized for each of the nine alternatives evaluated. The environmental impacts fall into three categories: radiological impacts, non-radiological impacts, and potential impacts from accidents. The discussion of the radiological impacts includes an estimate of the possible health effects resulting from radiation doses to the hypothetical maximally exposed offsite individual, the population within a 50-mile (80-kilometer) radius,(a) and the workers. The discussion of nonradiological impacts includes consideration of chemical contaminants released, the cost, land commitment, and time required to implement each alternative. The discussion of potential accident impacts includes consideration of radiological impacts resulting from spills and nonradiological impacts resulting from traffic accidents, injuries, and fatalities.

The impacts which have been estimated to result from any alternative considered in this supplement are consistent with those estimated in the NRC staff's March 1981 PEIS.

5.1 SUMMARY OF THE IMPACTS FOR THE ALTERNATIVES CONSIDERED

Table 5.1 summarizes the expected environmental impacts of the nine alternatives evaluated in Section 3.0. (The impact of accidents is discussed in Section 5.4.) For each alternative, the table lists estimates of: the offsite dose pathways/locations in which the dose is incurred; the doses for the maximally exposed offsite individual, the offsite population, and the workers; the cost of implementation; the long-term commitment of land and radioactive waste burial ground space; the elapsed time for completion; and the estimated number of transportation accidents expected during the shipping process.

For all evaluated alternatives the 50-year dose commitment to the maximally exposed individual ranges from 0 to less than 4 mrem to the thyroid, 0 to 0.4 mrem to the bone, and 0 to 5 mrem to the total body. These doses are based on exposures occurring over a period of 1 to 36 months and on a series of conservative assumptions as discussed in Section 3.0 and Appendix C. These doses are in addition to the approximately 87 mrem/yr received by the average Harrisburg resident from natural background (Klement et al. 1972).

The population dose ranges from 0 to less than 6 person-rem to the thyroid, 0 to 14 person-rem to the bone, and from 0 to 3 person-rem to the total body. The population doses from the atmospheric releases from onsite evaporation or solidification processes at TMI are distributed to a population of approximately 2.2 million persons within 50 miles (80 kilometers) of TMI. The population also receives an annual background radiation dose of

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(a) The dose to consumers of shellfish from Chesapeake Bay is also included.

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TABLE 5.1. Estimated Environmental Impacts of Water Disposal Alternatives

Section Number and Alternative	Offsite Dose Pathway/Location	Dose[(a)] Maximally Exposed Offsite Individual, mrem	Offsite Population, person-rem	Occupational, person-rem	Cost, $ millions	Long-Term Committed Space[(b)]	Elapsed Time for Completion, months	Estimated Number of Traffic Accidents
3.1.1 Forced Evaporation, Solidification, with Offsite Burial	Atmosphere/TMI	0.7 total body <4 thyroid	3 total body <6 thyroid	12 to 20	6.2 to 12	27,000 to 88,000 ft^3	9 to 35	0.6 to 1.9
3.1.2 Forced Evaporation, Solidification, with Retention Onsite	Atmosphere/TMI and River/TMI	0.7 total body <4 thyroid 4×10^{-4} bone 4×10^{-5} total body	3 total body <6 thyroid 0.03 bone 0.002 total body	14 to 25	6.7 to 8.8	10,000 ft^3 disposal site 15,000 ft^2 onsite	14 to 33	0.5
3.1.3 Distillation, Solidification, and Disposal of Bottoms, Followed by River Discharge	River/TMI	0.003 bone 0.002 total body <0.01 thyroid	0.6 total body[(c)] <1.3 thyroid	12 to 22	6.3 to 13	27,000 to 88,000 ft^3	9 to 35	0.6 to 1.9
3.2.1 Offsite Evaporation NTS	Atmosphere/NTS	(d)	3×10^{-4} total body	0.5 to 1	2.5 to 3.4	15,000 ft^2 at NTS	9 to 18	3.0
3.3.1 Onsite Solidification and Burial	Atmosphere/TMI and River/TMI	5 total body 4×10^{-4} bone 4×10^{-5} total body	3 total body 0.03 bone 0.002 total body	12 to 17	5.4 to 6.0	10,000 ft^3 disposal site 49,000 ft^2 onsite	10	0.5
3.3.2 Onsite Solidification with Offsite Burial	Atmosphere/TMI	2 total body	1.5 total body	6 to 13	34 to 41	390,000 to 460,000 ft^3 disposal site	18	10 to 12
3.4.1 Long-Term River Discharge	River/TMI and Chesapeake Bay	0.4 bone 0.06 total body	14 bone[(c)] 1 total body	2.5 to 7	2.9 to 3.6	10,000 ft^3 disposal site	24 to 36	0.5
3.4.2 Short-Term River Discharge	River/TMI and Chesapeake Bay	0.4 bone 0.06 total body	14 bone[(c)] 1 total body	2.5 to 6	2.8 to 3.3	10,000 ft^3 disposal site	1 to 2 (after retreatment of water)	0.5
3.5.1 Storage in Tanks Onsite	None	0[(e)]	0[(e)]	0[(e)]	0.1 to 1.3[(e)]	Small	0	0

(a) Critical organ doses are not reported where they are less than or equal to whole body doses. Doses from offsite burial are not included.
(b) Land commitments are in ft^2 or acres. LLW burial ground space is in ft^3. For metric equivalents, see text.
(c) Includes dose to all persons consuming seafood from the Chesapeake Bay area not just those within a 50-mile radius.
(d) Dose to the maximally exposed individual is not presented because of relatively uniform exposure.
(e) Considers only impacts during the storage. Disposal in the future would entail additional dose and cost.

approximately 190,000 person-rem. The doses resulting from the liquid releases to the Susquehanna River are distributed to a population of approximately 300,000 people who use the river for recreation and who consume river water and food products, plus an additional population of unknown size and geographic distribution that are consumers of shellfish from Chesapeake Bay. Annually, 300,000 people will receive 26,000 person-rem from background sources (assuming an average dose of 87 mrem/yr). The dose to personnel from evaporation at the NTS, 0.0003 person-rem, is distributed to a population of 6,500 persons who live 27 to 50 miles (43 to 80 kilometers) from the site. This population receives approximately 566 person-rem annually (total body) from natural background.

Essentially zero worker and offsite dose is projected to result from the no-action alternative of storing the water indefinitely at the TMI site. However, this estimate is associated only with the period of storage. Disposal of radioactively contaminated water is expected to be required regardless of the length of the storage period because the contaminants will remain slightly radioactive for several hundred years. The environmental impacts associated with disposal following even a relatively long period (10 to 30 years) of onsite storage would not be significantly different from impacts associated with near-term disposal, as discussed in this section. The dose to the population along the transportation route to the NTS or at the commercial LLW burial site operated by U.S. Ecology near Richland, Washington was determined to be zero. This is based on the small dose rate (calculated to be less than 0.1 mrem/yr) from a vehicle containing 5,000 gallons (19,000 liters) of untreated, accident-generated water.

Occupational dose estimates for all evaluated alternatives range from 0.5 to 25 person-rem. Essentially all of the external occupational doses received for all scenarios are due to other sources in the vicinity of the workers, not the accident-generated water. During the evaporation and solidification processes, workers would receive some additional total body dose from the inhalation of the tritium in the water vapor. This dose is included in the occupational dose estimates. The possible health effects resulting from these doses are discussed in Section 5.2.

The cost of implementing the various alternatives (excluding the no-action alternative) ranges from $2.5 to 41 million (as shown in Table 5.1). The most costly alternative ($34 to 41 million) is the direct solidification of the accident-generated water followed by transportation to and disposal at the commercial LLW burial site. The alternative proposed by the licensee, forced evaporation and solidification onsite with burial of the residue offsite, is estimated to cost from $6.2 to 12 million. The alternative of distillation, solidification, and disposal of bottoms, followed by river discharge, is estimated to cost about the same amount, $6.3 to 13 million. The remaining five alternatives are each expected to cost less than $9 million. The no-action alternative, indefinite storage in tanks, results in the least-near-term cost ($0.1 to 1.3 million). Three of the alternatives, the forced evaporation followed by solidification with retention onsite, onsite solidification and burial, and storage of the waste in tanks onsite, would probably require an additional expense for some years for monitoring to assure releases do not exceed the levels expected. Monitoring costs are included in the range of estimates for these alternatives.

The onsite requirements for long-term committed land range from no additional requirement to approximately 49,000 ft^2 (4,600 m^2) for direct solidification and onsite burial of the re-treated accident water. The offsite requirements ranged from no additional commitment of land to up to 460,000 ft^3 (13,000 m^3) of storage space in the LLW commercial burial site. One offsite alternative would commit approximately 15,000 ft^2 (1,400 m^2) at NTS. These impacts, as well as the result of chemical releases, are discussed further in Section 5.3. Additional details of these risk estimates are provided in Appendix Z of the PEIS (NRC 1981).

The estimated number of transportation accidents ranged from 0.5 to 12 for the alternatives (excluding no-action alternative). An accident is defined to mean any form of traffic accident and does not necessarily mean personnel injuries, fatalities or any disturbance to the cargo. The number of injuries, fatalities, and radiological events are described in Section 5.4.

5.2 RANGE OF RADIOLOGICAL IMPACTS AND POSSIBLE HEALTH EFFECTS

In estimating potential health effect results from both offsite and occupational radiation exposures as a result of the disposal of the accident-generated water, the staff used somatic (cancer) and genetic risk estimators that are based on widely accepted scientific information. Specifically, the staff's estimates are based on information compiled by the National Academy of Sciences (NAS) Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR 1972; BEIR 1980). The estimates of the risks to workers and the general public are based on conservative assumptions (that is, the estimates are probably higher than the actual number). The following risk estimators were used to estimate health effects: 135 potential deaths from cancer per million person-rem and 220 potential cases of all forms of genetic disorders per million person-rem.

The cancer-mortality risk estimates are based on the "absolute risk" model described in BEIR I (BEIR 1972). Higher estimates can be developed by use of the "relative risk" model along with the assumption that risk prevails for the duration of life. Use of the "relative risk" model would produce risk values up to about four times greater than those used in this report. The staff regards the use of the "relative risk" model values as a reasonable upper limit of the range of uncertainty. The lower limit of the range could be 0 because there may be biological mechanisms that can repair damage caused by radiation at low doses and/or dose rates. The number of potential cancers would be approximately 1.5 to 2 times the number of potential fatal cancers, according to BEIR III (BEIR 1980).

Values for genetic risk estimators range from 60 to 1100 potential cases of all forms of genetic disorders per million person-rem (BEIR 1980). The value of 220 potential cases for all forms of genetic disorders is equal to the sum of the geometric means of the risk of specific genetic defects and the risk of defects with complex etiology.

The preceding values for risk estimators are consistent with the recommendations of a number of recognized radiation protection organizations, such as the International Commission on Radiological Protection (ICRP 1977), the National Council on Radiation Protection and Measurements (NCRP 1975b), the NAS (BEIR 1980), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 1982).

The risk of potentially fatal cancers in the exposed work-force population is estimated as follows: multiplying the plant-worker-population dose (less than or equal to 25 person-rem for each of the alternatives) by the somatic risk estimator, the staff estimates that about 0.003 cancer deaths may occur in the total population of exposed workers. The value of 0.003 cancer deaths means that the probability of one cancer death over the lifetime of the entire work force as a result of the disposal operation is about 3 chances in 1000. The risk of potential genetic disorders attributable to exposure of the work force is a risk borne by the progeny of the entire population and is thus properly considered as part of the risk to the general public.

Conservative estimates of the radiological doses and dose commitments resulting from the disposal of the accident-generated water have been estimated in Section 3.0. Accurate measurements of radiation and radioactive contaminants can be made with a very high sensitivity so that much smaller amounts of radioisotopes can be recorded than can be associated with any possible observable ill effects. Furthermore, the effects of radiation on living systems have for decades been subject to intensive investigation and consideration by individual scientists as well as by select committees that have occasionally been constituted to objectively and independently assess radiation dose effects. Although, as in the case of chemical contaminants, there is debate about the exact extent of the effects of very low levels of radiation that result from nuclear-power-plant effluents, upper bound limits of deleterious effects are well established and amenable to standard methods of risk analysis. Thus, the risks to the maximally exposed member of the public outside of the site boundaries or to the total population outside of the boundaries can be readily calculated and recorded. These risk estimates for the disposal of the accident-generated water are presented below.

The risk to the maximally exposed individual is estimated by multiplying the preceding risk estimator by the estimated dose to the total body (less than 5 mrem for the alternatives evaluated). This calculation results in a risk of potential premature death from cancer to the maximally exposed individual from exposure to radioactive effluents (gaseous or liquid) from the disposal operations of less than 1 chance in 1 million. The risk of potential premature death from cancer to the average individual within 50 miles (80 kilometers) of the reactors from exposure to radioactive effluents from the disposal operation is much less than the risk to the maximally exposed individual. These risks are very small in comparison to cancer incidence from causes unrelated to the disposal of the accident-generated water.

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Multiplying the dose to the general population within 50 miles (80 kilometers) of TMI-2 from exposure to radioactive effluents (i.e., less than or equal to 3 person-rem to the total body for each of the evaluated alternatives) by the preceding somatic risk estimator, the staff estimates that less than 0.0004 cancer deaths (i.e., 4 chances in 10,000 of a single fatal cancer) may occur in the exposed population. The significance of this risk can be determined by comparing it to the total projected incidence of cancer deaths in the population within 50 miles (80 kilometers) of TMI-2 in 1980. Multiplying the estimated population within 50 miles (80 kilometers) of TMI-2 for the year 1981 (2.2 million people) by the current incidence of actual cancer fatalities (about 20%), about 440,000 cancer deaths are expected (American Cancer Society 1985).

For purposes of evaluating the potential genetic risks, the progeny of workers are considered members of the general public. However, it is assumed that only about one-third of the occupational radiation dose is received by workers who have offspring after the workers' radiation exposure (e.g., see paragraph 80 of ICRP 1977). Multiplying the sum of the dose to the population within 50 miles (80 kilometers) of TMI-2 from exposure to radioactivity attributable to the disposal of the accident-generated water (i.e., less than 3 person-rem total body, including gonads), and the estimated dose from occupational exposure (i.e., one third of 25 person-rem) by the preceding genetic risk estimator, the staff estimates that about 0.002 potential genetic disorders may occur in all future generations of the exposed population. Because BEIR III (BEIR 1980) indicates that the mean persistence of the two major types of genetic disorders is about five generations and ten generations, in the following analysis the risk of potential genetic disorders from the disposal operation is conservatively compared with the risk of actual genetic ill health in the first five generations, rather than the first ten generations. Multiplying the estimated population within 50 miles (80 kilometers) of the plant (about 2.2 million persons in the year 1981) by the current incidence of actual genetic ill health in each generation (about 11%), about 1.2-million genetic abnormalities are expected in the first five generations of the population (BEIR 1980) from causes unrelated to TMI-2 cleanup.

No significant radiological impact to aquatic or terrestrial biota resulting from any disposal alternative is expected (see Section 3.0).

5.3 RANGE OF NONRADIOLOGICAL IMPACTS

The major nonradiological impacts identified include the cost of implementation, long-term commitment of land and burial ground space, and the elapsed time required to perform the alternative.

Significant chemical releases are expected only in the alternatives involving direct discharge of the accident-generated water to the river. The rate of release of water to the river was assumed to be controlled to conform to a maximum of 25 ppm boron. No sodium release is expected because both of these alternatives require retreatment of all of the water (achievable case). No discernible impact on the ecology or downstream water users are expected from chemical releases.

Cost estimates were made based on staff consideration of the cost of major activities expected to be required for each disposal option. Although the estimates are not based on an extremely detailed level of information, they are believed to reasonably bound alternative costs and provide an adequate basis for considering cost as a disposal impact. The cost of implementing the various alternatives ranges from $0.1 to 41 million. The least costly alternative is the no-action option in which the accident-generated water would be stored in tanks onsite. However, this cost estimate is associated only with the period of storage. Since some method of disposal is expected to be required, associated costs would approximate the costs estimated for the near-term disposal options (neglecting inflation) presented in this section. The estimated cost range, $0.1 to 1.3 million, includes construction of additional tankage and the potential requirement to replace existing tanks if the retention period is long enough for tank degradation to cause leaks.

The most costly alternative is onsite solidification of the accident-generated water and subsequent transport to a LLW burial site. The most significant costs for this alternative are for solidification and packaging, $13 to 15 million, and transportation and burial, $21 to 26 million. The alternative selected by the licensee, forced evaporation and solidification of evaporator bottoms at the TMI site and burial in the LLW burial site is estimated to cost from $6.2 to 12 million. The major costs for this alternative are: forced evaporation, approximately $3.6 million; solidification, $0.9 to 2.9 million; and transport and burial, $1.7 to 5.5 million. The cost of the remaining seven alternatives ranges from $2.5 to 13 million.

The requirements for long-term commitment of land include land at the TMI site, the NTS, and burial space in a commercial LLW burial site. The solidification of evaporator bottoms with burial onsite would require an estimated 15,000 ft^2 (1,400 m^2) of land at the TMI site. The direct solidification of the accident-generated water followed by onsite burial would require an estimated 49,000 ft^2 (4,600 m^2). The accident-generated water stored in tanks onsite would require only a small additional land area. Offsite evaporation of the accident-generated water would involve the commitment of an estimated 15,000 ft^2 (1,400 m^2) of land at the NTS.

The solidification of evaporator bottoms followed by shipment to the commercial LLW disposal site would require 27,000 to 88,000 ft^3 (765 to 2500 m^3) of disposal space. The direct solidification of the accident-generated water would require between 390,000 and 460,000 ft^3 (11,000 to 13,000 m^3) of space in a LLW disposal site. The alternatives which include the retreatment of the accident-generated water with the SDS or EPICOR II system would require approximately 10,000 ft^3 (283 m^3) of LLW burial space for the disposal of resin liners.

The estimated time commitments for completion of the alternatives except for the no-action alternative (storage in tanks onsite) vary from 1 month following retreatment of the accident-generated water to 3 years. Three of the alternatives would require some monitoring beyond the elapsed time for completion of the alternative.

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No significant nonradiological impact to aquatic or terrestrial biota resulting from any disposal alternative is expected (see Section 3.0).

5.4 RANGE OF ACCIDENT IMPACTS AND THEIR PROBABILITY

The potential accident impacts include both radiological and nonradiological impacts. Table 5.2 lists the major radiological accident for each of the alternatives as well as the resulting dose estimates. The worst-case radiological accident scenario for many of the alternatives is the assumed rupture of an 11,000-gallon (42,000-liter) tank of accident-generated water prior to retreatment (base case), which would flow into the Susquehanna River. This scenario is estimated conservatively (only a fraction of the water could reach the river), and the resulting 50-year dose commitment doses are quite low (0.015 mrem bone and 0.002 mrem total body for the maximum individual, 0.7 person-rem bone and 0.015 person-rem total body for the population).

For the no-action alternative, a second, although extremely improbable, accident scenario was included, the loss of the total inventory of accident-generated water in an uncontrolled discharge. Conservative 50-year dose commitments are estimated to result in a maximum individual bone dose of 3 mrem and a total body dose of 0.4 mrem. The population 50-year dose commitment was estimated at 140 person-rem to the bone and 4 person-rem to the total body.

Two scenarios were considered for radiological transportation-related accidents: the release of the entire inventory of a 5,000-gallon (19,000-liter) tank truck to a roadway, and the release of the same inventory to the Susquehanna River. For the first scenario, vegetation growth on the spill site would be impaired until the boric acid would be removed. If it were removed and the radionuclides were left, a person consuming 50 pounds (23 kilograms) of crops, harvested 14 days after the accident, grown on the site where the water was deposited could receive a maximum estimated dose of 3000 mrem bone and 60 mrem total body (50-year committed dose). An individual remaining at the accident site for 2 hours might receive 0.2 mrem total body (50-year dose commitment). For the second scenario, release of 5,000 gallons (19,000 liters) to the Susquehanna River, the estimated doses to the maximally exposed individual would be less than 0.005 mrem bone and 0.001 mrem total body, with a population dose of less than 0.3 person-rem bone and 0.008 person-rem total body (50-year dose commitment). The boron in the released accident-generated water would not affect the fish.

Transportation related accidents for the remaining alternatives are not expected to result in any radiological impact. An accident involving a truck transporting concrete slabs or resin liners is not expected to result in a measurable release to the environment or radiation dose to the public.

Although terrestrial and/or aquatic biota in the vicinity of an accident could be adversely affected, the impact would be temporary and of no long-term significance.

TABLE 5.2. Estimated Environmental Impacts of Radiological Accidents

Section Number and Alternative	Nontransportation			Transportation		
		Dose			Dose	
	Accident Description(a)	Maximum Individual, mrem	Population, person-rem	Accident Description	Maximum Individual, mrem	Population, person-rem
3.1.1 Forced Evaporation, Solidification, with Offsite Burial	11,000 gallon tank ruptures; unretreated water flows into Susquehanna River	0.015 bone 0.002 total body	0.7 bone 0.015 total body	Truck accident	No dose	No dose
3.1.2 Forced Evaporation, Solidification, with Retention Onsite	11,000 gallon tank ruptures; unretreated water flows into Susquehanna River	0.015 bone 0.002 total body	0.7 bone 0.015 total body	Truck accident	No dose	No dose
3.1.3 Distillation, Solidification, and Disposal of Bottoms Followed by River Discharge	11,000 gallon tank ruptures; unretreated water flows into Susquehanna River	0.015 bone 0.002 total body	0.7 bone 0.015 total body	Truck accident	No dose	No dose
3.2.1 Offsite Evaporation NTS	- - - - - - - - Not applicable - - - - - - - -			5,000 gallons released on garden	60 total body 3000 bone	
				5,000 gallons released into river	<0.008 bone <0.001 total body	<0.3 bone <0.008 total body
3.3.1 Onsite Solidification and Burial	- - - - - - - - Not applicable - - - - - - - -			Truck accident	No dose	No dose
3.3.2 Onsite Solidification and Burial at Hanford	- - - - - - - - Not applicable - - - - - - - -			Truck accident	No dose	No dose
3.4.1 Long-Term River Discharge	11,000-gal tank ruptures; unretreated water flows into Susquehanna River	0.015 bone 0.002 total body	0.7 bone 0.015 total body	Truck accident	No dose	No dose
3.4.2 Short-Term River Discharge	11,000-gal tank ruptures; unretreated water flows into Susquehanna River	0.015 bone 0.002 total body	0.7 bone 0.015 total body	Truck accident	No dose	No dose
3.5.1 Storage in Tanks Onsite	Ultimately all tanks fail; water flows into Susquehanna River	3 bone 0.4 total body	140 bone 4 total body	- - - - - - - - - - Not applicable - - - - - - - - -		

Table 5.3 lists the results of the nonradiological accident calculations for each of the alternatives, all but one of which involve offsite shipments. Also shown in Table 5.3 are the material shipped and the number of shipments required for each of the alternatives. The number of potential accidents resulting from transportation requirements range from 0.5 to 12 for each of the eight alternatives involving shipping. The number of injuries estimated for each of these alternatives ranges from 0 to 10. The estimated number of fatalities ranges from 0 to 0.8. As expected, the greater the number of shipments, and the further the shipping distance, the larger the number of potential accidents, injuries, and fatalities. Appendix D describes the basis for the transportation-accident estimates.

TABLE 5.3. Estimated Nonradiological Accident Impacts from Offsite Shipments

Section Number and Alternative		Number of Shipments	Estimated Number Accidents	Estimated Number Injuries	Estimated Number Fatalities	Material Shipped[a]
3.1.1	Forced Evaporation, Solidification, with Offsite Burial	80 to 260	0.6 to 1.9	0.5 to 1.6	0.04 to 0.13	Solidified evaporator residues
3.1.2	Forced Evaporation, Solidification, with Retention Onsite	60	0.5	0.4	0.03	Resin liners
3.1.3	Distillation, Solidification, and Disposal of Bottoms, Followed by River Disposal	80 to 260	0.6 to 1.9	0.5 to 1.6	0.04 to 0.13	Solidified evaporator residues
3.2.1	Offsite Evaporation NTS	420	3.0	2.6	0.2	Bulk liquid (5,000-gallon tankers)
3.3.1	Onsite Solidification and Burial	60	0.5	0.4	0.03	Resin liners
3.3.2	Onsite Solidification and Burial	1300 to 1600	10 to 12	8.2 to 10	0.6 to 0.8	Solidified accident-generated water (288-ft^3 concrete slabs)
3.4.1	Long-Term River Discharge	60	0.5	0.4	0.03	Resin liners
3.4.2	Short-Term River Discharge	60	0.5	0.4	0.03	Resin liners
3.5.1	Storage in Tanks Onsite	0	0	0	0	No transportation

(a) For metric equivalents, see text.

6.0 CONCLUSIONS

On the basis of a review of the environmental impacts associated with a broad range of alternatives for disposal of the accident-generated water, the staff concludes:

- The licensee's proposed water disposal action and the eight alternative methods evaluated in this supplement could each be implemented without significant environmental impact. The potential health impact to both workers and the offsite public from any of the alternatives is very small.

- The most significant potential impact associated with taking action to dispose of the water is the risk of physical injury associated with transportation accidents.

- No alternative is clearly preferable from an environmental impact perspective. Although the quantitative estimate for some potential impacts varied among alternatives, these differences were not judged sufficiently large to allow for either identification of a clearly preferable alternative or rejection of any of the nine evaluated options.

- Storage of the accident-generated water on the TMI site for an indefinite period, even though it involves small potential environmental impact, is inappropriate because it only postpones action that will ultimately be required to dispose of the existing water. Additionally, extended storage presents no significant environmental advantage over relatively near-term action to dispose of the water. Because of the relatively long radiological half-life and relatively small quantity of contaminants in the water, the environmental impacts of disposal following even a relatively long storage period would not be significantly different from impacts associated with near-term disposal.

- The environmental impacts estimated from implementation of any disposal alternative evaluated in this supplement fall within the range of impacts estimated in the NRC staff's original Programmatic Environmental Impact Statement (NRC 1981) on the cleanup.

- The licensee's proposed action of onsite evaporation combined with offsite disposal of evaporator bottoms is an environmentally acceptable disposal method.

Therefore, the staff finds that the benefits of disposal action outweigh the small associated impacts and that the licensee's proposed evaporation of the accident-generated water will not significantly affect the quality of the human environment.

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7.0 DISCUSSION OF COMMENTS ON THE DRAFT SUPPLEMENT

Pursuant to 10 CFR 51, the Programmatic Environmental Impact Statement (PEIS) related to the decontamination and disposal of radioactive wastes as a result of the March 28, 1979, accident at Three Mile Island Nuclear Station, Unit 2, Draft Supplement No. 2, was transmitted in December 1986 with a request for comments to federal and state government agencies noted in the Foreword. In addition, a notice requesting comments from interested members of the public was published on December 31, 1986 (51 FR 47323). The comment letters received by the staff and portions of the transcripts of public meetings held on January 21, 1987, February 25, 1987, and March 25, 1987 by the Commission's Advisory Panel for the Decontamination of TMI-2 are reproduced in Appendix A of this final supplement.

The NRC staff's consideration of these comments and its disposition of the issues involved are reflected in part by revisions in the pertinent sections of this supplement (designated by change bars) and by the following discussion. Comments and questions that were clearly outside the scope of this supplement, such as those concerning the origin of certain regulations and the integrity/ability of the licensee to conduct water disposal, are not addressed. Comments that were addressed in the text of the draft and/or final versions of Supplement 2 are not otherwise addressed. The organization of this section corresponds generally to the ordering of the subject material in the supplement; however, comments on similar topics are grouped together. The numbers in parentheses designate the numbers (as given in Appendix A) that were assigned to the comment letters received and the meeting transcripts (see pp. A.1-A.4).

7.1 PURPOSE AND SCOPE OF THE SUPPLEMENT AND THE REGULATORY PROCESS

7.1.1 The Regulatory Process (7)(15)(16)(17)(18)(20)(24)

Several commenters questioned the lack of engineering detail in the proposed evaporation system, or requested specific details on several of the alternatives. Several questioned the NRC's plans for monitoring various performance aspects of the alternatives. Questions concerned plans to publicize releases. In addition, one commenter asked that the staff include in the final supplement mitigating measures for some of the unanticipated monitoring results of some alternatives. There were also inquiries about the license amendment process and whether or not there would be additional opportunities for public comment.

The draft and final supplements, like the impact statement they supplement, are programmatic in nature. That is, they are intended to explore the potential impacts of the various steps in the broad action of decontamination and disposal of the accident-generated wastes. As such, engineering design, environmental monitoring, and accident mitigation are discussed only to the extent necessary to bound the potential environmental impacts. This final

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supplement incorporates suggested revisions, written and oral public comments, and the staff's response to those comments.

The Commissioners, who will approve a disposition method in principle, will then grant the staff authority to amend the license to allow disposal of the water. Additionally, there will be an opportunity during the license amendment process for the public to request a hearing. The timing of the hearing, i.e., whether prior to or after issuance of the amendment, will be determined by the Commission.

Once the license is amended to remove the prohibition against disposal of the accident-generated water, the licensee will submit a safety evaluation report and specify the particular engineering and monitoring details of the approved method. If at any time during this process there is reason to believe that the environmental impact of disposal will result in impacts outside the range of those predicted in the PEIS, as supplemented, then disposal will not be permitted by the NRC.

7.1.2 Political Versus Scientific Decision (16)(17)(27)

Several commenters expressed the opinion that a decision on how to dispose of the water is a political or policy matter rather than a scientific decision. One commenter stated that scientific evidence is irrelevant.

Although the staff is aware of the political sensitivity of the issue, it is required by the National Environmental Policy Act (NEPA) and NRC implementing regulations to evaluate the proposed disposal on the basis of quantifiable environmental impacts. The supplement is an effort to accomplish this.

7.1.3 Need for a Decision at This Time (15)(16)(17)

Several commenters stated that the proposed supplement was premature because the water is not all processed and ready for disposal at the present time.

The evaluation of the environmental impacts associated with various postulated alternatives was first addressed in the draft and final PEIS (NRC 1981). The licensee, in late July 1986, submitted its proposal for disposing of the accident-generated water. Draft Supplement No. 2 to the PEIS was prepared in response to the licensee's request for approval to dispose of the water. Although all the accident-generated water has not been completely processed and is not currently available for disposal, the draft supplement conservatively accounts for all required processing and disposal activities in estimating environmental impacts. Sufficient information currently exists, including water processing operational data, to fully characterize the environmental impacts associated with ultimate water disposal. The range of impacts listed in this report is conservative and bounding.

7.1.4 Pennsylvania Law (15)(20)

A commenter asked whether or not an NRC decision could violate Pennsylvania environmental law.

The Commonwealth of Pennsylvania regulates those activities over which it has been given jurisdiction by Congress though the Atomic Energy Act, the NEPA, the Resource Conservation and Recovery Act (RCRA), or other legislation. However, there are areas over which the NRC has jurisdiction that the Commonwealth does not. NRC consultation with the Commonwealth of Pennsylvania on issues relevant to the TMI-2 cleanup which has been ongoing and will continue, is expected to prevent any possibility of jurisdictional problems.

7.1.5 If Pennsylvania Were an Agreement State (15)(20)

The commenter wanted to know what the consequences would be if Pennsylvania became an Agreement State before the water disposal issue was resolved.

Subject to the limitations of Section 247b of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2021b), an Agreement State can assume from the NRC the authority to regulate certain radiological materials. Thus, the Commonwealth could request the authority to regulate byproduct material made radioactive by exposure to the process of utilizing special nuclear material (reactor fuel), which would include the accident-generated water. The Commonwealth could also request authority to regulate the disposal of low-level waste within its borders. The NRC shall not, however, relinquish to any state the authority to regulate the operation of a utilization facility (e.g., TMI-2). Should the Commonwealth apply to become an Agreement State with respect to byproduct material, as described above, and low-level waste disposal, the authority of the NRC and the Commonwealth regarding the disposition of the accident-generated water would be determined at that time. No adverse consequences to effective regulation would be anticipated.

7.1.6 Best Method (15)(17)

Commenters stated that because the supplement indicates that none of the methods are clearly preferable, it is up to the NRC to prove which method is the best.

The National Environmental Policy Act and NRC's implementing regulations specify decisionmaking procedures and information that must be provided in the record of decision in cases requiring environmental impact statements. The agency must "identify all alternatives considered by the agency in reaching its decision, specifying the alternative or alternatives which were considered to be environmentally preferable. An agency may discuss preferences among alternatives based on relevant factors including economic and technical considerations and agency statutory missions." There is no requirement that a "best method" must be identified. In this case, the staff has examined environmental impacts associated with the licensee's proposed action and alternatives and, while not identifying a "best method," has found that none of the alternatives evaluated in this supplement would significantly impact the quality of the human environment.

7.1.7 Future Use of the TMI Site (15)(20)

The commenter asked about restrictions on long-term use of the site, and when the NRC would consider long-range monitoring at the site.

The future use of the TMI site is an issue in this supplement to the extent that it affects any of the stated alternatives. However, it is the current NRC policy that all reactor sites ultimately be decommissioned by removing essentially all radioactive materials. The NRC's limitations on long-term radioactive waste storage at the TMI site have been, and continue to be, consistent with this policy. Therefore, the staff assumed, for all alternatives, that the TMI site would ultimately be decommissioned by removing essentially all radioactive materials. After decommissioning and confirmatory surveys, the license to possess and use radioactive materials would be terminated. At that time, presumably, the owners would have the option of using or disposing of the site in any manner consistent with the laws and regulations in effect at that time.

Any onsite disposal of concreted water, concreted evaporator bottoms, or other low-activity materials under 10 CFR 20.302 would be considered only if they were consistent, from a radiation dose standpoint, with future unrestricted use of the site.

7.1.8 Relationship to Post-Defueling Monitored Storage (16)

The commenter challenged NRC's position that waste, including the accident-generated water, should not remain on the island longer than necessary. The question was raised in light of the licensee's proposal to place the reactor in a post-defueling monitored storage configuration following defueling.

Whether on not the plant should be placed in the post-defueling monitored storage configuration will be the subject of a separate supplement. The question will be decided on the basis of overall safety, costs (both in resources and radiation exposure) and benefits. In the absence of overriding benefits associated with storing waste onsite, the staff believes that waste should be disposed of as expeditiously as possible. In this case, the staff concluded that there is no significant benefit from continued onsite storage.

7.1.9 Length of Supplement (17)

The commenter stated that the draft supplement was deficient because unlike "previous EISs concerning the disposal of radioactive waste," which "totaled more than a thousand pages," it contains only about 120 pages.

The July 1, 1986 Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (NEPA) (40 CFR 1500-1508) indicate that "the text of final environmental impact statements ... shall normally be less than 150 pages and for proposals of unusual scope or complexity shall normally be less than 300 pages."

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As the supplement to an existing document, the staff believes this document's current level of detail meets both the letter and intent of NEPA.

7.1.10 Level of Detail (27)

One commenter stated that the draft supplement purports to exhaust the subject, yet lacks important detail. It was also suggested that additional information should be provided on baseline sampling, etc., for the various alternatives.

As a programmatic environmental impact statement prepared to facilitate decisionmaking, there was no intention to exhaust the subject. The intention was rather to bound the impact utilizing both available specific information and reasonable assumptions. Furthermore, the staff concluded that conditions in and around the site had not changed sufficiently since issuance of the PEIS to warrant additional baseline sampling.

7.1.11 Use of EPA Limits (13)(17)(23)(28)

Several commenters suggested that more information on EPA limits for radionuclides in drinking water should be included.

A careful review of 40 CFR 149 has confirmed that the presentation given in Section 2.2 accurately reflects EPA's regulations governing radionuclides in drinking water. Although it is possible to calculate the concentration of each particular radionuclide that will result in an assumed 4-mrem dose, it could be misleading because the dose from all radionuclides must be included when radionuclides are mixed.

7.2 PROPERTIES OF THE WATER

7.2.1 The Need for Further Data/Analysis of the Water (13)(15)(17)(24) (27)(28)

Several commenters asked how the analyses were obtained. It was pointed out that much of the water is currently in contact with highly radioactive components and that there are 500 radioisotopes formed in the fission process. One individual suggested an approach based on the inventory of the reactor core before the accident. Several commenters expressed a lack of confidence in the water analysis, and asked that multiple analyses be performed. Another commenter suspected that there were "un-filterable fines" in the water, and quoted the PEIS as stating that fines could delay cleanup.

The NRC staff has reviewed water analysis data that form the bases for characterizing accident-generated water in this report. An independent analysis by the NRC of a sample of water has confirmed the characterization provided by the licensee. For the purpose of conservatively estimating the environmental impacts associated with disposal alternatives, the information in this report is considered complete. The impacts of radionuclides that can reasonably be expected or postulated to be present in the water following processing have been quantified.

Although the staff believes the environmental impacts in this report are bounding, as a matter of standard operational practice, additional confirmatory analyses will be required in connection with any disposal method approved by the Commission. Such analyses will serve to confirm, or not, the characterization presented in this report. Disposal operations, monitored by NRC personnel, would not be permitted if water characteristics were significantly different from those detailed in this report.

7.2.2 Omission of Certain Radionuclides (13)(17)(25)

Commenters charged that the draft supplement was inadequate because radionuclides that were known to be present in the water when the PEIS was prepared were omitted in the draft supplement. The "important" ones were considered to be Mb-95 (sic), Zr-95, Sp-125 (sic), Tm-125m (sic), Te-127m, Te-129m, Co-58, Te-I-129m, and Ru-103.

In fact, all radionuclides predicted to be in the processed water in the PEIS were addressed in the draft supplement. The majority of the radionuclides that were reported in the PEIS as being present in untreated water have been through 8 to 65 half-lives of decay since the time the PEIS was published. The half-lives of the omitted radionuclides are: Niobium-95, 35 days; zirconium-95, 62.5 days; antimony-125, 2.7 years; tellurium-125m, 58 days, tellurium-127m, 109 days; tellurium-129m, 34 days; cobalt-58, 71 days; and ruthenium-103, 40 days. The staff was unable to identify "Te-I-129m." A discussion of iodine-129, although present below the detection limit, has been added to the final supplement.

7.2.3 Quantities of Transuranic Elements (13)(15)(16)(17)(24)(25)

Several commenters wanted to know the specific quantity of transuranic elements in the water. (This included specific data on plutonium, americium, curium, etc.) One commenter stated that transuranics are more toxic than cesium and that they are soluble in water. Another commenter stated that although they are less soluble, they are more toxic.

The specific concentrations of transuranic elements in the water are less than the analytical limit of detection in analyses that have been performed to date; however, specific maximum concentrations of transuranic elements as determined from the lower limits of detection have been provided in this supplement. The best measure of radiotoxicity is radiation dose. The dose from these elements, assuming they are present at the lower limit of detection, has been included in the supplement. Chemical toxicity of the transuranics is negligible at the environmental concentrations expected. Impact from transuranic elements was found to be insignificant.

7.2.4 Alpha Contamination from Uranium (13)(17)

The commenter suggested that uranium is quite water soluble and that the water must contain large quantities of alpha-emitting radionuclides because uranium mine water does.

The accident-generated water differs from mine water in two ways that affect the alpha contamination. First, the alpha radiation in uranium mine water is primarily from radium and its daughter products, which are formed by the radioactive decay of uranium. The radium is separated from the uranium in the milling process and re-forms only very slowly because of the several thousand year half-life of the naturally occurring uranium isotopes. Second, all of the accident-generated water will have been treated by ion-exchange, which is one of the most effective methods of removing uranium from water (in fact, it is the basis of the resin-in-pulp uranium milling process). Water analyses verify that little alpha contamination is present following treatment.

7.2.5 Quantities of Chemicals, Oil, and Grease (15)(16)(27)

Additional information on the quantities of oil, grease, and chemicals in the water was requested.

The only chemicals that have been added to any portion of the accident-generated water to date are as follows: 1) boric acid and sodium hydroxide, which are described in the supplement; 2) hydrogen peroxide, which will have decomposed to oxygen and water; 3) diatomaceous earth, which is used as a filter aid in defueling--the majority of which is removed by the filtration process; 4) various flocculating agents, which are used to aid filtration--concentrations at the time of addition are in the parts-per-billion range. Most of the flocculant is removed, with the particulates it attaches to, in the filtration process; and 5) chemicals that the water may pick up from being used in the reactor building, which are likely to include oil and grease, calcium, oxides of iron, sulfates, and other trace constituents. Chemicals do not become radioactive by contact with the fuel under the current conditions. These elements are mostly removed by the separation, filtration, and ion exchange processes to which the water is subjected routinely during use and before storage in tanks.

None of the chemicals would be expected to vaporize to an appreciable extent in the evaporation option or be discharged to a significant extent in the river discharge option (except as noted in the supplement). Air and water discharges in any option must conform to applicable regulations.

7.2.6 Loss of Tritium (17)(25)

The commenter pointed out that the original PEIS listed approximately 2,500 curies of tritium whereas the supplement addresses only 1,020 curies.

The reader is referred to the initial PEIS, pages 7.45 and 7.46 and Table 7.22. Loss rates of tritium are predicted for various water uses (losses are due primarily to exchange with atmospheric hydrogen in moisture in the air and radioactive decay). Those predictions are in very good agreement with the observed value.

7.2.7 Concentration Relative to Maximum Permissible Concentration (MPC) (16)

One commenter asked if the concentrations of radioisotopes in the water exceeded the NRC-prescribed MPC.

The base case accident-generated water concentration exceeds the MPC in drinking water in unrestricted areas for strontium-90 (367 times MPC), tritium (43 times MPC), and cesium-137 (1.8 times MPC). In addition, the detection limit for iodine-129 is 10 times the MPC so it may also exceed MPC up to 10 times. Other radionuclides range from 23% of MPC for antimony-125/tellurium-125m to less than 0.0005% of MPC for europium-152.

7.2.8 Limitations of Water Cleanup Processes (15)(16)(24)(27)

Several commenters questioned the efficiency of the water cleanup systems, the submerged demineralize system (SDS) and EPICOR II system. One commenter also was concerned about the effects of chemicals, oil, and grease on these ion exchange systems. One commenter stated that alpha recoil causes alpha-emitting material to pass through filters.

In each alternative considered, the water will be filtered, then processed by the SDS and EPICOR II cleanup system. Both of these systems are ion exchange systems. The SDS utilizes a cesium-specific resin. The SDS processing is always followed by EPICOR II processing before the water is stored. Oil and grease in the influent water may foul the resins so that resin change-out is required more frequently. Operating procedures prevent operating the system with resins that are not effectively removing contaminants. The EPICOR II system is similar to demineralizers that are used to produce extremely high purity water for scientific and industrial applications. Typically, the purity of the water from such a system exceeds the purity of water that has been distilled in glass. The very high concentrations of boron in the accident-generated water limit the anion removal effectiveness; however, removal effectiveness is still expected to be very high.

Alpha recoil is unlikely to affect radionuclides in solution. Impacts estimated in this report are based on analysis of the water after filtration.

7.2.9 Microorganisms in the Water (9)(27)

The commenters wanted to know if microorganisms from the water could create a health hazard.

The microorganisms in the accident-generated water that is in use are routinely killed by the addition of hydrogen peroxide. (The hydrogen peroxide decomposes to oxygen and water in the process.) This procedure also could be used before SDS and/or EPICOR II processing of the water to avoid column plugging. Evaporative boiling could be expected to kill off any remaining microorganisms; if it did not, they would remain in the evaporator bottoms and be solidified. In the river discharge options (without distillation), any microorganisms that survived hydrogen peroxide treatment and then passed through the ion exchange columns and filters could be discharged to the river. It is possible that such organisms might represent an altered strain of organism, but radiation and peroxide resistance are the only likely effects.

7.2.10 Water Volume (14)(15)(16)(20)

Commenters questioned the amount of water that would have to be disposed as well as the accuracy of water volume estimates.

The present quantity of accident-generated water on the TMI site is approximately 2.1 million gallons and is expected to rise to approximately 2.3 million gallons because of dilution. That quantity may be affected by either of two processes: evaporation, which decreases the water volume, or mixing (commingling) with water that does not meet the criteria for accident-generated water. The mixing process dilutes the radionuclide concentration, but increases the volume. The final quantity of water requiring disposal might exceed 2.3 million gallons; however, this is not expected to materially affect the environmental impact predicted for any of the alternatives. The final volume of water has no effect on the amount of radioactive material present.

7.2.11 Variability of Water (16)(28)

Because the accident-generated water is currently in numerous locations, one commenter suggested that the supplement enumerate the location and analysis of each separate body of water. Another commenter asked if the tanked water might be reused before disposal.

As noted in this report, some water is still being used in defueling and decontaminating the facility. This water will require processing prior to disposal, and its current precise location and radiological content are not considered relevant to ultimate disposal. There is sufficient experience with the water cleanup systems that the staff is confident that the enumerated average concentrations and quantities are achievable. If the concentrations obtained substantially exceed the estimates given, then disposal will be judged to be outside the scope of the supplement.

7.2.12 Strontium-90 (14)

The commenter questioned the statement that strontium-90 in the environment is not routinely measured.

Strontium-90 is generally present in levels below the lower limit of detection in soil and water, but is relatively easy to monitor in milk, which provides the principal human exposure pathway.

7.2.13 Boron and Boric Acid Concentration (15)(20)

The commenter asked at what level would the concentration of boric acid or boron be cause for concern.

Limits for release of chemicals are established by the Commonwealth of Pennsylvania within EPA guidelines. In evaluating environmental impacts, the staff's concern about the concentration of boron and boric acid in accident-generated water has been related to the potential use of the water. For disposal in the river, the principal concerns are the health of humans and animals that may drink the water, the health and productivity of plants that may come in contact with the water, and the health of fish that may live in the water. A limit of 25-parts-per-million (ppm) boron in water discharged to the river was established by the previous National Pollutant Discharge Elimination System (NPDES) permit, but is absent from the present one. Restricting boron concentrations in released water to the 25-ppm level appears adequate to protect health and the environment for all uses.

7.2.14 Discussion of the Impact of Drinking Accident-Generated Water (14)(23)

One commenter suggested that the discussion of drinking the accident-generated water be deleted because of potential confusion. Another commenter suggested that rather than calculating the dose to a person drinking 1 liter of water, the dose from consuming 2.2 liters per day for 70 years be presented.

The staff has considered the possibility that the data might be misinterpreted, but concluded that the discussion remain because of the beneficial perspective it provides. Consumption of more water over a longer time bears no relationship to any alternative and is therefore irrelevant for this supplement.

7.2.15 Dose from Consumption of Accident-Generated Water (23)

The commenter suggested that the radiation dose from the consumption of 1 liter of accident-generated water was very much higher than the value presented and presented calculations to support, for example, a value of about 3,680 mrem bone from strontium-90 instead of 960 mrem calculated by the NRC.

The discrepancy is the result of the commenters use of obsolete data (ICRP 1959) in the calculations. It was assumed that 9% of the strontium intake would go to the bone; however, more recent internationally accepted models (ICRP 1968), based on experimental evidence, assume that only 5.1% of the strontium would deposit in the bone. The rate of strontium elimination from bone used by the commenter was also based on older data that assumed an effective half-life of 6,400 days. Current standards call for a value of 2,900 days. The commenter also used a fraction of 0.051 of the intake distributed to the critical organ. The current value is 0.09. (Other discrepancies in the commenter's calculations, a beta energy of 5.5 versus 5.65 MeV

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for strontium, and calculation of an infinite dose commitment in lieu of the 50 years stated in the NRC calculation, have only a minor effect on the calculated dose.)

7.2.16 Tritium Concentration Process (15)(20)

A commenter on tritium concentration processes in the environment referenced quotes from the NCRP contained in the draft Supplement and inquired if lack of concentration processes meant lack of health effects. The commenter also asked if any studies had shown tritium concentration processes in the environment.

The fact that there are no tritium concentration processes means that no living cell will have tritium concentration greater than the medium (air, water, food products) from which the tritium was obtained. The radiation emitted by the tritium is quantified and expressed in terms of radiation dose. Radiation dose is equated with health effects.

The staff is not aware of any studies where a tritium concentrating mechanism has been demonstrated or claimed.

7.2.17 Biological Half-Life of Tritium (17)

The commenter asserted that the staff, in quoting a 10-day biological half-life of tritium, was ignoring that it may be permanently incorporated into cells.

The draft includes a full discussion of the retention of tritium in biological systems. See page 2.6 of the draft supplement and page 2.4 of this supplement.

7.2.18 Radiation Doses from Tritium (17)(25)

The commenter asserted that no attempt has been made to calculate the dose from tritium incorporated into the body.

On the contrary, virtually all the total body dose calculated for both the maximally exposed individual and for the population is from the intake of tritium and other radionuclides in the water.

7.2.19 Hazard and Half-Life (16)

The commenter stated that to determine how long a material remains hazardous the half life is multiplied by ten; therefore, tritium with a biological half-life of 10 days (for most of it) is hazardous in the body for 100 days.

The rule of thumb of 10 half-lives is sometimes used with respect to the time that a site containing buried waste should be monitored. This is because cutting a quantity in half 10 times leaves only 0.098% of the initial quantity, which is rarely significant. A half-life is most accurately viewed as the time for half the total quantity of a material to decay or be eliminated.

7.2.20 Description of Tritium (13)(15)(17)

A commenter objected to the description of tritium as a radioactive nuclide or radionuclide, suggesting instead that it be termed radioactive water. Another commenter stated that the text in places "reads as if the tritium in the water is there as the gas."

The staff has used the scientific terms in the supplement according to convention. The staff believes the nature and chemical form of the tritium and the incorporation of tritium atoms into water molecules have been adequately explained.

7.2.21 Heavy Water (13)(17)

The commenter stated that the tritium is present as tritiated water or heavy water.

Tritiated water is a correct designation for the chemical form of the tritium in water. Heavy water normally refers to deuterium oxide. (Deuterium is the non-radioactive isotope of hydrogen having one neutron and a mass of two.) Heavy water is, therefore, an incorrect designation.

7.2.22 Possible Reduction in the Radiation Standards for Beta Radiation (17)

The commenter alleged that the draft supplement was inadequate because it failed to address a proposal to reduce the radiation standards for beta radiation because re-analysis of the Hiroshima bomb data shows that neutrons were less damaging than previously thought.

In fact, re-analysis of the Hiroshima bomb data shows that neutrons were more damaging than previously thought (that is, that fewer neutrons account for the observed biological effects). These data also indicate that the damage from gamma radiation may have been overestimated. The bomb data yield little information about beta radiation. The radiation standards are not likely to change significantly; however, the recommended dose estimation methods are constantly being refined. Changes are not likely to alter the estimated doses by more than a factor of 2, and that amount of conservatism is already built into the models used in the supplement.

7.3 ALTERNATIVES AND THEIR IMPACTS

7.3.1 Alternatives Involving Onsite Evaporation

7.3.1.1 Effects of Weather (16)

The commenter asked what weather conditions would require evaporator shutdown.

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Only weather conditions that are sufficiently severe to damage equipment, such as tornado conditions, would require shutdown of the evaporator. Weather phenomena such as inversions would not require evaporator shutdown. The estimated impacts include operations during such conditions.

7.3.1.2 Travel Distance of Vapor (16)

The commenter asked what distance the water vapor would travel from the site during evaporation.

Water vapor containing the tritium will travel downwind indefinitely until it decays, condenses, or exchanges with other water. The model used to estimate the dose assumes no depletion by condensation or exchange, but does consider the dilution and decay that occurs naturally. The population dose that is calculated includes all the dose out to a distance of 50 miles.

7.3.1.3 Effect of Temporary Evaporator Shutdown (24)

The commenter asked if there would be a concentration of radionuclides each time the evaporator was shut down and restarted.

Evaporator shutdown and startup procedures are not expected to increase effluent release rates over steady-state operation.

7.3.1.4 Shipment of Evaporator Bottoms as Dry Powder (14)

The commenter suggested that the evaporator bottoms could be shipped as a dry powder.

The staff based its assessment of impacts on information contained in the licensee's formal proposal which indicated that evaporator bottoms would be solidified. Although solidification of this type of relatively low-level radioactive waste is not a requirement, the staff has not considered shipment of evaporator bottoms as a dry, suspendable powder. As noted in this report, the details of any Commission approved disposal method will be reviewed by the NRC staff to assure that the environmental impacts have been bounded by the PEIS and supplements.

7.3.1.5 NRC Inspection of Evaporation (15)(16)(17)(20)(25)

Several commenters questioned the content and adequacy of NRC's program to ensure that evaporation be done in accordance with license provisions and NRC regulations.

NRC staff approval of the licensee's safety evaluation report for the disposal system and the operating procedures would be required before disposal could begin. The onsite NRC staff would also periodically inspect the operation to ensure that required controls were in place.

7.3.1.6 Effect of an Evaporator Malfunction (24)

The commenter asserted that the staff had neglected to analyze the impact of an evaporator malfunction in the draft supplement.

Most malfunctions of the evaporator system would result in its failure to operate. Impact associated with evaporator malfunction is bounded by the truck failure accident (see Section 3.1.1.3).

7.3.1.7 Low-Level Waste Burial Ground Acceptance of the Waste (15)(20)

The commenter expressed concern that a low-level waste burial ground may refuse the waste.

Acceptance of the waste by burial ground operators is not expected to be a problem, as noted in this report (see Section 3.1.1.1). The Department of Energy has granted the licensee's request for waste volume allocation.

7.3.1.8 Radiation Doses from Onsite Evaporation (14)

The commenter noted that the maximally exposed member of the general population would receive a higher dose to the bone than to the total body in contrast to the population that would receive more total-body dose than bone dose.

The differences in total body and bone dose occur because individuals closest to the release point receive most of their exposure from particulate "fallout," which they receive largely from vegetables and livestock raised in the area. The particulate material contains the strontium that gives a dose to the bone.

The population farther downwind receives relatively little fallout because most of it was already deposited closer to the release point. Instead, this population receives most of its exposure from tritium, which is diluted, but not considered to deposit in the same way that particulates do. Tritium is considered to give a whole body dose.

7.3.1.9 Transportation of Cement (28)

The commenter asked if transporting cement to the site was included in the accident predictions.

No. Similar to other minor impacts, including transporting the evaporator to the site and the cost to prepare the supplement, transportation of cement to the site was not included.

7.3.1.10 Hypalon Cap on Concreted Waste (15)(20)

The commenter was concerned about the nature of the Hypalon cap and its relation to the "disastrous clay cap used at chemical sites in California."

Hypalon is a plastic material commonly used in the construction of retention ponds. It is expected to have a useful lifetime of many years. However, the analysis of the environmental impact presented assumes rapid and complete deterioration of the Hypalon. The protection afforded by it would lessen the impact of the alternative to some level below that predicted in the supplement.

7.3.1.11 Experience with Disposal by Evaporation (8)(15)(16)(17)

The commenters charged that there are no medical studies that state that the proposed disposal method is safe. Some asked about other locations where contaminated water is disposed of by evaporation. Others referred to evaporation as an experimental process.

Although the risk as stated is not proven to be zero, there is a substantial body of scientific evidence to indicate that the risk to the maximally exposed individual is about the same as the risk from a day of natural background radiation.

Evaporation is practiced widely in the nuclear industry and other industries. As noted in Section 3.6.11, open cycle evaporation of tritium-contaminated water is performed at Maxey Flats, Kentucky.

7.3.1.12 Population Dose from Foodstuffs Exported Beyond 50 Miles (14)

The commenter pointed out that in the draft supplement the staff had calculated the dose to persons within a 50-mile radius from the consumption of foodstuffs, but not the dose to persons consuming food raised within the 50-mile radius and exported.

The staff has used the NRC-accepted methodology, documented in NRC Regulatory Guide 1.109, to calculate dose to the population within 50 miles. That methodology does not include potential dose to the population outside a 50-mile radius.

7.3.2 Alternatives Involving Bulk Liquid Shipment

7.3.2.1 Truck Accidents While Shipping Liquid (14)

The commenter suggested that the calculation of radiation impact from an accident involving the breach of a truck carrying accident-generated water should consider human exposure from groundwater contamination.

The analysis of the 50-year dose commitment to an individual consuming 50 pounds of vegetables picked 14 days after 5,000 gallons of accident-generated water was spilled on the land conservatively bounds the impact. A single application of 5,000 gallons of accident-generated water to the surface is unlikely to affect a significant groundwater resource.

7.3.2.2 Non-Worker Exposure from Evaporation at the Nevada Test Site (15)(20)

The commenter inquired about civilians upwind at the Nevada Test Site. The staff has presumed that the concern is the general public downwind.

The Nevada Test Site is a 1,300-square-mile (336,700-hectare) posted area, access to which is controlled by the federal government for security reasons. If the accident-generated water were evaporated there, it might be possible for some member of the public to trespass onsite to the downwind area and receive some dose from the evaporation process. However, the staff would classify such an occurrence in the category of an accident. The probability and radiological consequences would be less than for the accidents that are specifically addressed.

7.3.2.3 Pond Evaporation at the Nevada Test Site (14)(28)

One commenter noted that population dose estimates for this alternative do not include exposure to airborne particulates. Also, the basis for doubling the doses to account for intake from agricultural production was questioned as overly conservative.

The pond would be uncovered only during the evaporation period when it would be kept wet most of the time. Evaporation residues would be immobilized by one of a number of techniques following evaporation. Dispersion of particulates over 27 miles to the nearest resident would be unlikely and insignificant. Dose estimates were doubled (rather than study actual agricultural practices in the region) to bound the impact.

7.3.2.4 Concentration Used to Calculate Accidental Impact (28)

The commenter questioned the water concentration used to calculate the impact of accidents because the concentration in the water is not uniform.

The average concentration, as discussed in Section 2.0, was used to calculate the impact of accidents. Although some tanks do contain higher concentrations, the staff believes that the assumptions of 100% release, the lowest possible river flows, and maximally exposed offsite individual are sufficiently conservative to bound the impact of any probable accident.

7.3.2.5 In Situ Vitrification (28)

The commenter questioned the feasibility and energy costs for in situ vitrification of waste that might remain from pond evaporation at the Nevada Test Site.

In situ vitrification is feasible for this volume of material and would require approximately 160 megawatts of electricity. The pond dimensions, as described, may not be optimal for in situ vitrification and might be altered were this alternative selected.

7.3.2.6 Rail Transportation (15)

The commenter suggested that the accident-generated water could be shipped in 200 rail cars of 10,476-gallon capacity.

Transportation of the accident-generated water by rail is both technically feasible and legally permissible. Truck transportation was selected for the purpose of the programmatic analysis presented in the supplement because it is generally more available, and the staff considered that it would provide a range of impacts that would encompass all the alternatives. A more detailed analysis indicates that this is the case even though the probability of an accidental nonoccupational fatality (per quantity of material shipped) is slightly higher by rail than by truck in suburban and urban areas (although the probability is lower in rural areas). The probability of an accidental nonoccupational injury is considerably lower by rail (Cashwell et al. 1986).

7.3.3 Alternatives Involving Direct Solidification

7.3.3.1 De Minimis Waste Impacts Analysis Methodology (15)(20)

The commenter asked why the NRC has adopted the de minimis waste impacts analysis methodology and inquired about alternative methodologies.

De Minimis Waste Impacts Analysis Methodology is the title of a document describing a computer code that was prepared for the NRC to analyze very low-level contaminated materials. The code uses the pathway dose-conversion methodology of ICRP-30, which is widely accepted.

7.3.4 Alternatives Involving River Discharge

7.3.4.1 Population Dose from Shellfish (14)(28)

The commenter criticized the draft supplement for including dose to persons outside the 50-mile radius from shellfish harvested from the Chesapeake Bay.

The dose from consumption of Chesapeake Bay shellfish was conservatively included in response to previously expressed concern over this issue. Inclusion of this impact did not alter staff conclusions on the river discharge option.

7.3.4.2 Potential for Release of Unretreated Water (15)(20)

The commenter wanted to know why discharge of a batch of untreated water was considered unlikely.

In addition to the fact that a discharge of a batch of untreated or treated water has not occurred in the last 7 years, there are procedural controls that require the sampling and analysis of all batches of water before they are discharged. Both employees and their supervisors receive training and are required to follow the procedures. The licensee's quality assurance organization provides overview. The NRC routine inspection program provides another level of assurance.

7.3.4.3 Dams Affecting River Discharge (27)

The commenter stated that little was said about the number of dams downstream and that the dams could intensify the buildup of contaminants.

Figure 4.6 shows the four dams downstream of TMI. The models used to estimate dose assume incorporation of radionuclides in sediment and from sediment into fish. This is one of the principal reasons why the maximally exposed individual, who is assumed to have a large fish component in his diet, receives a much higher dose than average.

7.3.4.4 Fish Contamination Estimates (14)

The commenter challenged the near-field dilution factor of 0.2 and the flow rate of 3,150 cfs used in calculating the dose to the maximally exposed individual from river discharge as being too conservative.

The 0.2 dilution factor and the flow rate for the fish pathway were taken directly from the PEIS, Appendix W, for consistency. The 0.2 dilution factor is conservative, and the 3,150-cfs flow represents the minimum flow of the channel of the river where the outfall is located.

7.3.4.5 Impact on Fish (27)

The commenter asserted that the draft supplement dismissed the impact on fish, which support an enormous industry in the Chesapeake Bay.

Neither any planned alternative nor any accidental discharge would have a significant impact on fish survival or reproduction in the Susquehanna River or Chesapeake Bay.

7.3.5 Alternatives Involving Onsite Storage

7.3.5.1 Probability of Release of All Water (28)

The commenter believed that the release of all the water would be impossible rather than improbable because the water was in 25 separate locations.

It is doubtful that the water would remain in 25 locations following defueling. Because the storage mode is undefined, release of all the water was selected to bound the impact.

7.3.5.2 Ice Jams (15)

The commenter stated that the potential of ice jams during river flooding was a potential disadvantage of leaving the accident-generated water in tanks onsite.

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An ice jam is one potential method by which failure of one or more water storage tanks could occur. Such an event is somewhat credible in spite of dikes surrounding the Island, however, only with very high river flows and cold temperatures. The combined effect of high dilution rates from high river flows and minimal sport fish gathering because of cold temperature would probably reduce the radiation dose received by downstream water users to about 1% of the dose calculated for the tank failure accidents that were analyzed.

7.3.5.3 Long-Term Storage Onsite (15)(20)

The commenter wanted to know why no impediments to onsite storage were expected before termination of the license.

The current facility license allows possession of radioactive materials in the quantity and chemical form in which they occur at the TMI site. Before decommissioning and the associated removal of an NRC license, safe storage of this material would be considered an acceptable action in conformance with NRC regulations.

7.3.6 Rejected Alternatives

7.3.6.1 Presentation of Certain Rejected Alternatives (15)

The commenter called the inclusion of ocean disposal and disposal at Maxey Flats flippant because they are not available.

The alternatives were established early in the supplement preparation process. As data were gathered, the alternatives were sorted into two categories, those that were evaluated and those that were rejected without a quantitative evaluation. Those that were clearly unavailable were placed in the rejected category rather than deleted from the report entirely. The staff believes their brief mention, as presented, meets the intent of NEPA and the NRC's implementing regulations.

7.3.6.2 Potential For Reuse in Reactors (15)

The commenter challenged the staff's conclusion that the water could be put into the river, but not into an operating reactor.

The purity of materials used in reactor coolant systems is regulated by both the NRC and by international standards. Materials such as river water, tap water, or common table salt would have a corrosive effect on reactor system materials. Such considerations influenced the staff to reject recycle of the accident-generated water and concentrated evaporator bottoms.

However, the principal reason for rejecting the recycle potential without additional consideration of the possibility of further purification is that the ultimate environmental impact of any such alternative would not be appreciably less than that of other alternatives involving discharge to the environment. This is because water used in reactor coolant systems is routinely discharged to the environment following cleanup and sampling.

7.3.7 Additional Alternatives

7.3.7.1 Over-Water Evaporation (16)

The commenter suggested that it might be best to evaporate the water over the ocean.

The staff is not aware of existing facilities to do this. The environmental impact is not expected to be greatly different from those of other alternatives that require transporting the water and releasing it to the environment.

7.3.7.2 Containers (15)

The commenter suggested that NUREG/CR 39773 (sic), prepared by Brookhaven National Laboratory, be reviewed. The report discusses the use of alternative containers for low-level waste containing large amounts of tritium. The use of these containers was suggested as a safer method of keeping the water onsite.

NUREG/CR-3973, Alternative Containers for Low-Level Waste Containing Large Amounts of Tritium (Gause 1984), discusses appropriate packaging for burial of glass vials of tritium gas and for tritium-contaminated organic solvents. Individual 210-liter (55-gallon) drums were considered to contain a maximum of 1,000 curies of tritium. The document addresses soil corrosion at licensed burial grounds, pressure generated from radiolysis and/or biodegradation (a 76-liter container required 10^5 Ci before it burst) and diffusion of hydrogen through materials.

The tritium concentrations considered, and the fact that container integrity for 100 to 200 years following burial was the primary focus of the document, led the staff to conclude that the referenced document contains no viable alternative for storage or disposal of the accident-generated water.

7.3.7.3 Closed Cycle Evaporation Distillation (15)(16)(17)(20)(23)

Some commenters suggested the use of closed cycle evaporation (distillation of the water) as one method of further purifying the water while eliminating environmental release. One also suggested that this be done before sea disposal, deep-well injection, or hydrofracturing.

Closed cycle evaporation followed by river disposal was determined to be a feasible alternative and is discussed in Section 3.1.3 of the Final Supplement. Disposal of closed cycle distillate at sea, by deep-well injection, or by hydrofracture would have all the associated institutional constraints and transportation risks associated with these alternatives and was rejected for the reasons discussed in Section 3.6.

7.3.7.4 Future Low-Level Waste Site (17)

The commenters asked if in the future there would be a low-level waste site nearby that might reduce the risk of shipment. They also asked why the alternative of storing the water until a regional site was available was not considered.

Pennsylvania is scheduled to have a low-level waste disposal site by 1993, but has not yet selected a site or passed the required legislation to do so. The alternatives involving shipment to Washington State were selected to bound the impact.

7.3.7.5 Onsite Storage Alternatives (15)(17)(20)

The commenters asked about alternative ways to store the water onsite.

Because the consequences of accidents involving the water are slight and present storage practices are within regulatory limits and license conditions, the staff determined that it was unnecessary to consider a variety of non-disposal options.

7.3.7.6 Other Alternatives (15)(16)(17)(20)

Several commenters expressed the opinion that there are, or soon will be, other feasible alternatives that the staff has chosen not to make known to the public. One commenter mentioned a distillation process to remove tritium from water.

The staff is unaware of feasible alternatives that are not addressed in this supplement that would reduce the environmental impact. The staff is of the opinion that the number and range of alternatives assessed respond fully to the letter and intent of NEPA.

7.4 EXISTING ENVIRONMENT

7.4.1 Meteorology (15)(20)(25)(27)

One commenter described the meteorology of the site as a "closed-air basin" and pointed out that inversions, bans on burning, and fog are often noted in the area. Others noted that prevailing winds carry radioactivity toward one group of people more often than not. The commenters asked for a study of the meteorology of the area.

Atmospheric dispersion and resulting doses from airborne radioactive material were modeled using actual site meteorology, including directions, periods of inversion, and very stable air. The onsite data are typical of valley sites. The meteorology of the TMI site has been compared with the meteorology of other reactor sites and found to be fairly typical in the frequency of inversions and low wind speed conditions. The period of time

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that the wind blows in a particular direction is likely to be small relative to the period of evaporation so that dispersion occurs in multiple directions.

7.4.2 Water Table Gradient (28)

The commenter asked that the units for the water table gradient be supplied.

Water table gradient is the ratio of change in water table elevation with distance. Because the units of elevation and distance are the same (feet, meters, etc.), they cancel out, and the quantity is unitless.

7.4.3 Agricultural Productivity Figures (14)

The commenter questioned the productivity figures used in the draft supplement.

Average figures for Pennsylvania were used in the draft supplement. The suggested figures would increase the population dose commitment from consumption of vegetables by only a few percent.

7.4.4 Background Radiation Level (28)

The commenter stated that the background radiation level used in the report, 87 mrem/yr, was too low on the basis of aerial radiation monitoring data and indoor radon levels in the area.

The value of 87 mrem may be low; however, it is the most recent EPA published value. Additionally this value, an approximation, allows for reasonable perspective on the impacts discussed in this report.

7.4.5 Population Distribution (14)

The commenter noted that different population distribution figures were used by the NRC and the licensee.

The figures used in the supplement are 1980 census figures updated for emergency planning purposes by the NRC. Changes in the population figures would have no effect on doses to the maximally exposed individual and a very small effect on calculated population doses.

7.4.6 Groundwater Elevation (14)

The commenter noted that normal groundwater elevation is 282 feet mean sea level rather than 280 feet as reported.

The groundwater elevation presented in the supplement is taken from the PEIS without update. This change is not expected to affect the environmental impact of the licensee's proposal, the alternatives, or possible accidents.

7.4.7 Other Water Users Downstream (14)

The commenter noted that Chester County and the City of Baltimore, Maryland have water intakes on the Susquehanna River downstream from the site, yet people living in these communities were not included in the number of downstream water users.

The Chester County intakes currently operate less than 1% of the time (approximately 6 hours per month). Baltimore intakes are used only during droughts. The staff is aware of the existence of these intakes. The probability that they would be operating during an accidental release of the accident-generated water was considered negligible.

7.4.8 Activity in the River Versus the Accident-Generated Water (16)

The commenter questioned how long it takes for a quantity of tritium equivalent to that in the accident-generated water to pass by the TMI site in the normal flow of the Susquehanna River.

At the average river water tritium concentration of 178 pCi/L and the average river flow of 34,000 cubic feet per second, approximately 69 days are required for 1,020 curies of tritium to pass the TMI site.

7.4.9 Flood Plain (5)

The commenter suggested that disposition of the accident-generated water may be within the 500-year flood plain and therefore fall within the providence of Executive Order 11988, Flood Plain Management, and the implementing guidance "Flood Plain Management Guidelines for Implementing Executive Order 11988."

The staff has determined that none of the accident-generated water disposition alternatives are critical actions as defined by the guidelines, and none are within the base flood plain. Therefore, none of the alternatives are affected by the Order.

7.4.10 Study of the Impact of TMI on the Susquehanna River (15)(27)

The commenter stated that the staff had not consulted a privately funded study of the impact of TMI on the Susquehanna River by the TMI Health Fund.

This is true. The referenced study has not been published and is not available to the NRC staff.

7.4.11 Swimming (28)

The commenter challenged the assumption of 120,000 person-hours per year swimming in the Susquehanna River downstream as being too high.

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The staff concurs that this is probably a very conservative estimate. It was used for consistency with the PEIS.

7.5 ENVIRONMENTAL IMPACT

7.5.1 How Doses Were Calculated (13)(17)(18)(28)

Some commenters observed that the appendix on dose calculation was written so that a person without a technical background could not understand how the calculations were made. Some commenters asked for additional information on assumptions used in the calculations.

The staff regrets the fact that the science of estimating radiation dose is sufficiently complex to defy a simple, concise, and readily understandable explanation for those who have not studied the subject. The methodology used is explained in detail in the referenced documents (which have been supplied to the NRC and Commonwealth of Pennsylvania library reading rooms). Appendix C lists those parameters that either must be supplied by the user of the dose calculation program or adjusts the standard (default) values used in the program. A tutorial on dose calculation methods is beyond the scope of this supplement.

7.5.2 Cumulative Dose from Cleanup (15)(16)(17)(20)(24)(25)(27)

Several commenters pointed out that the population in the vicinity of TMI had already been subjected to radiation, including krypton, from TMI and that this was not addressed. A question as to whether the staff had assumed that all plant, aquatic, and human life is chemically and radioactively pure before exposure to radioactive emissions from the water also seemed to address this issue. A definitive cumulative total radiation dose was requested. One commenter suggested that the effects of the Peach Bottom Plant and TMI-1 should also be included along with future discharges from other nuclear power plants.

The issue of overall impact from accident cleanup was estimated in the PEIS, NUREG-0683. Supplement 2 includes the latest information on the environmental impact of disposition of the accident-generated water. The impacts are within the range of those estimated.

7.5.3 Safe Level of Radiation (15)(16)(17)(20)(24)(27)

Several commenters pointed out that many people do not believe that any radiation dose is safe. A similar statement indicated there is no scientific proof that tritium is not harmful to humans. It was also suggested that there is a variation in cancer risks among individuals and among types of cancers. A commenter asked for discussions of cancer incidence, genetic effect, and increased susceptibility to chronic disease.

The NRC performs its regulatory function on the presumption that there is no absolutely safe level of radiation (including radiation from tritium). It

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is for this reason that incremental risks are presented as they are in Section 5.0. This philosophy is also represented in the conclusions. Increased susceptibility to chronic disease is not known to result from low-level radiation exposure.

7.5.4 Effect of Radiation on a Fetus or Developing Child (27)

The commenter charged that, with the exception of the discussion on drinking accident-generated water, little was said about the disproportionate effect of radiation on a fetus or developing child.

The discussion on drinking accident-generated water does not actually address the effect of radiation on the young; it discusses the fact that a greater radiation dose results from intake of the same amount of radioactive material by a smaller body mass. The dose to the maximally exposed member of the general population also reflects this effect. For example, the maximally exposed member of the general population for the evaporation alternative is a child who, in addition to breathing air downwind of the TMI site and consuming vegetables raised downwind, also drinks exclusively goat's milk from goats raised downwind. An adult, infant, or fetus at the same location would receive less dose from the same activities. Limits for general population exposure take into account the greater radiosensitivity of the young, as do the dose-to-health-effect conversion factors used by the staff in Section 5.0.

7.5.5 Lower Acceptable Levels of Radiation (16)

The commenter observed that acceptable radiation levels had been reduced several times and that additional reductions are possible in the future.

The staff acknowledges that reductions in standards may occur. However, the impact of any of the alternatives is nearly an order of magnitude below all the current standards. The staff considers that there is a very small probability that future reductions in permissible radiation levels would make disposal of the accident-generated water appear unacceptable from a radiation protection standpoint.

7.5.6 Incremental Risk (16)

The commenter asked for an explanation of incremental risk.

We are all exposed to numerous risks. Incremental risk is the addition to that risk that would result from the proposed action or an alternative.

7.5.7 Fractional Incidence of Cancer (28)

The commenter suggested that an appendix clarifying fraction cancer estimates be included.

The staff believes that the discussion in Section 5.2 and new material added to the summary clearly depict the likelihood of various effects.

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7.5.8 BEIR I Versus BEIR III (14)(28)

One commenter suggested that the document clarify the use of these two reports. Another stated that BEIR III was a more appropriate reference for the statement that no species is more radiosensitive than man.

These reports, prepared by the Committee on the Biological Effects of Ionizing Radiation of the National Research Council, are among the most authoritative works on the subject. The 1980 report, BEIR III, is intended to update the 1972 report, BEIR I. It concentrates primarily on the long-term somatic and genetic risks to persons exposed to radiation at low doses. The BEIR III report, in particular, exhibits a range of operation on the extrapolation from high to low doses of radiation. BEIR III does not address species differences in radiosensitivity.

7.5.9 Aerosol Properties (15)

The commenter stated that the aerosol effect of radionuclides was different in a biological sense than if they were simple particles or air gases.

The staff believes that the methodology used to estimate health effects is appropriate.

7.5.10 Cost Breakdowns (15)(16)(20)

The commenters asked how much of a factor cost was in selecting alternatives. Also, commenters stated that cost and/or time should not be factors and asked where the funds would come from.

Cost estimates are presented to allow comparison of the commitment of resources associated with the alternatives. Although the staff considered cost, the primary focus was on direct human health and environmental consequences. Cost differences were insufficient to influence conclusions. The licensee has proposed to pay for water disposal from the cleanup funds which come from a variety of sources, both public and private.

7.5.11 Inflation and Regulatory Delays in the Cost Basis (15)(20)

The commenter asked whether or not inflation and/or regulatory delays were considered in estimating costs.

They were not considered. Cost figures are presented for a relative comparison of alternatives.

7.5.12 Psychological Stress and Other Possible Evaluation Criteria (15)(16)(17)(20)(25)

Several commenters requested that psychological stress be studied before a decision was made. One commenter alleged that evaporation or river dumping would have a negative economic impact on the area because people would decline to vacation in or purchase foodstuffs from the area.

A unanimous Supreme Court decision [Pane v. NRC 460 U.S. 766 (1983)] regarding the restart of TMI-1 in April 1983 determined that potential psychological stress, and other impacts based on perceived risk and not on a change in the physical environment are beyond the reach of NEPA.

7.5.13 Population Dose from Consumption of Farm Products (14)(28)

The commenters questioned input ingestion parameters and production figures used to calculate population dose from foodstuffs, as well as the livestock exposure assumptions.

Ingestion parameters from NRC Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," weighted for the age distribution of the population were used. Production figures from the PEIS were used. Dairy cattle were assumed to be on pasture six-tenths of a year (about 7 months) and beef cattle were assumed to be on pasture all year. Changes of less than 50% in any of these parameters are not expected to affect the doses calculated by the staff. Very large variations would be required to affect the conclusions.

7.5.14 Cell Repair (15)(20)

The commenter asked the staff to clarify the statement "...biological mechanisms that can repair damage caused by cancer (sic) at low levels." The quote should have read, "...biological mechanisms that can repair damage caused by radiation at low levels."

A complete discussion of the interaction of radiation with living organisms is beyond the scope of this supplement; however, a summary is presented here.

When a photon of radiation enters a living cell there are four possible outcomes: 1) the photon may pass through the cell without causing any effect; 2) ionization may occur in the cell, killing the cell, in which case it will be replaced by natural growth and division of the surrounding cells (except in nerve tissue where its function is taken over by adjacent nerve cells); 3) ionization and recombination of the ions may occur without any apparent effect; or 4) the cell may be damaged, but survive. In this case, it is likely to go into a dormant period. During the dormant period it may be repaired, either by processes that originate within the cell or by processes that originate in surrounding cells. The mechanism of cell repair is not yet well understood. If the cell is not repaired completely during the dormant period, it may die and be replaced, or it may be altered in such a way that it undergoes the rapid and uncontrolled growth and division process known as cancer or malignancy.

7.5.15 Radiation Hazards (15)(16)(17)(22)(23)(24)(25)

Several commenters stated that tritium and/or radiation affects reproduction, causes a rise in infant mortality, and causes brain damage in mice.

One commenter claimed that the radiological significance of tritium is not related to its inherent toxicity. The exposure models and risk estimators used by the NRC were challenged, as well as the credibility of the NCRP. One commenter provided alternative dose estimates. One commenter suggested that disposal of the water should await the results of human exposure studies performed by the Atomic Energy Commission (predecessor to both the NRC and DOE) from 1950 to 1952.

A complete discussion of the risk from radiation or the qualification of standards-setting organizations is beyond the scope of an environmental impact statement. The studies cited by most commenters involve far greater exposures than are possible from the accident-generated water or reference atypical populations. The dose estimates presented by some commenters equate evaporation into the atmosphere with administering a substantial fraction of the material to infants. The exposure models and risk estimators used in this supplement are based on experimental evidence on animals and studies of exposed human populations. They are accepted by national and international scientific organizations, as discussed in Section 5.0.

7.5.16 Infant Deaths from Evaporation (22)

The commenter claimed that 100 to 400 excess infant deaths and an equal number of adult deaths would result from the proposed release.

The methodology used by the commenter departs substantially from the methodology used by the staff in estimating 0.0004 premature deaths in the offsite population. The NRC staff's methodology is consistent with the recommendations of a number of recognized radiation protection organizations.

7.5.17 Dilution (15)

The commenter asserted that, on the basis of the linear risk model, dilution would not reduce radiation dose.

The linear risk model does not specifically address the effect of dilution or concentration of a radionuclide when released to the environment. According to the linear risk model, risk is directly proportional to radiation dose. For any particular radionuclide (in a given physical and chemical form), lower intakes result in lower doses and therefore lower risks.

7.6 OTHER COMMENTS AND QUESTIONS

7.6.1 Need for Independent Study or Review (15)(16)(20)

Several commenters requested an independent review of the licensee's proposal and/or this supplement to the PEIS. Others complained that the initially announced 45-day comment period was too short.

This supplement is available for review by the public and federal, state, and local agencies. It is undergoing review by the Advisory Panel to the

Commission. The EPA, the National Council on Radiation Protection (which is chartered by Congress to perform independent reviews of radiation issues), the U.S. Department of Energy, the Pennsylvania Department of Health, and the Maryland Department of Natural Resources have commented, as have numerous environmental groups and individuals. The staff believes that additional review beyond this is not warranted. The comment period was extended from the original 45 to 90 days to allow additional comments.

7.6.2 The Terms "Disposal" and "Ultimate Disposal" (15)(16)(20)(25)(27)

The commenters asked that the term "ultimate disposal" be clarified. One commenter claimed that dumping and evaporation were not true methods of disposal but were methods of dispersion. Another stated that the accident-generated water will become part of living organisms.

Accident-generated water has a specific legal definition related to both its history and its tritium concentration (see Section 2.1). Disposal, or ultimate disposal, as used by the staff, would be any process that resulted in the dispersal of the accident-generated water in the environment in such a manner that there was no such identifiable water in existence, or that resulted in the placement of all identified accident-generated water in a permanent repository. The staff is not aware of permanent repositories for liquid waste with the possible exception of the weapons test cavities at the Nevada Test Site and the deep injection wells and grout systems.

The staff concurs that in an environmental sense, river discharge and evaporation are dispersal and their environmental impact has been assessed as such.

7.6.3 Independence of Pacific Northwest Laboratory (15)

The commenter observed that the Pacific Northwest Institute (sic) and the Department of Energy seemed to be together, indicating a lack of independence.

Because the U.S. Department of Energy (DOE) is not a licensee of the Nuclear Regulatory Commission and is not responsible for disposal of the water, independence from DOE is not required. The Pacific Northwest Laboratory (PNL) is operated by Battelle Memorial Institute under a contract with DOE. The NRC is able to acquire the services of PNL (and other national laboratories) on a cost-reimbursement basis by means of an interagency agreement. Personnel from PNL assisted the NRC staff in preparing the draft and final supplements. Personnel from the DOE Richland Operations Office have an overview responsibility for the work, but in reality have had little interaction with the staff on the project. The NRC, as the issuing agency, is responsible for the content of this supplement.

7.6.4 Water from Decommissioning TMI-1 (16)

The commenter wanted to know if there might be a similar water volume requiring disposal at the time TMI-1 would be decommissioned.

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No. TMI-1, like all reactors except TMI-2, has provisions for disposing of low-activity waste water if it is within technical specification limits. The need for the regulatory action for TMI-2 occurs because of special provisions placed on it following the accident.

7.6.5 Other Uses for the Evaporator (17)

The commenter expressed concern that the evaporator might be used for other purposes after it was brought onsite.

The staff is unaware of other planned uses for the evaporator; however, all onsite uses must conform to NRC regulations and be within the scope of the PEIS, as supplemented.

7.6.6 Descriptions (15)(24)(27)

One commenter asserted that the words "small," "minimum," and "fraction" were misused. The following sentence was given as an example: "The fraction released would be dependent upon concentration in the water input, the feed rate to the evaporator, the design of the evaporator, and the removal fraction from plate-out on the moisture separator, ducts, and stack." One commenter found the use of the word "merely" in connection with the no action alternative objectionable.

Such summary statements are used to introduce and summarize quantitative information. The draft and final supplements quantify to the best available level the concentration in the evaporator input (see Table 2.2) and the feed rate to the evaporator (up to 3 gallons per minute in the draft and up to 20 gallons per minute in the final). The following sentence in the text estimates the overall release fraction (1% or less in the draft) from the evaporator. The staff believes the level of quantification is accurate, appropriate, and according to the conventions of common English usage.

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APPENDIX A

COMMENTS ON THE DRAFT SUPPLEMENT TO THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

APPENDIX A

COMMENTS ON THE DRAFT SUPPLEMENT TO THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

The table below lists the comment letters received in response to the draft supplement in the following order: federal government agencies; state government agencies; citizen groups and businesses; and individual citizens. The identification numbers in Column 2 of the table correspond to the discussion of comments received in Section 7.0. The page number where the letter first appears in this appendix is shown in Column 3.

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U.S. Department of the Interior Bruce Blanchard, Director Environmental Project Review	7	A.11
U.S. Environmental Protection Agency Richard E. Sanderson, Director Office of Federal Activities	28	A.51
U.S. Nuclear Regulatory Commission Advisory Panel for the Decontamination of TMI-2 Arthur E. Morris, Chairman	19	A.32
Maryland Department of Natural Resources Torrey C. Brown, M.D., Secretary	3	A.5
Maryland Department of Natural Resources Richard I. McLean, Administrator Radioecology, Power Plant Research Program	6	A.10
Maryland Department of State Planning Guy W. Hager, Director, Maryland State Clearinghouse for Intergovernmental Assistance	1	A.5
Pennsylvania Department of Environmental Resources Mark M. McClellan, Deputy Secretary	31	A.54
Pennsylvania Department of Health George K. Tokuhata, Dr. P.H., Ph.D., Director Division of Epidemiology Research	2	A.6

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Beverley Davis	27	A.50
Comments received at the January 21, 1987 TMI Advisory Panel Meeting	15(c)	A.59
Comments received at the February 25, 1987 TMI Advisory Panel Meeting	16(c)	A.77
Comments received at the March 25, 1987 TMI Advisory Panel Meeting	17(c)	A.102

(a) Attachment to letter from Encyclopedia Britannica not received.
(b) Attachment to letter not reproduced.
(c) Excerpt from transcript of public meeting.

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Below is a numerical listing of the comments letters received.

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Maryland Department of Natural Resources Torrey C. Brown, M.D., Secretary	3	A.5
Pennsylvania Intergovernmental Council Sandra L. Kline, Special Assistant Intergovernmental Review Process	4	A.8
U.S. Department of Defense James F. Johnson, Chief, Planning Division Department of the Army	5	A.8
Maryland Department of Natural Resources Richard I. McLean, Administrator Radioecology, Power Plant Research Program	6	A.10
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Donald E. Hossler	8	A.11
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National Council on Radiation Protection and Measurements, Warren K. Sinclair President	10	A.13
U.S. Department of Health & Human Services John C. Villforth, Director Center for Devices and Radiological Health	11	A.24
Joseph J. DiNunno	12	A.25
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GPU Nuclear Corporation F. R. Standerfer, Director, TMI-2 4410-87-L-0032 Document ID 0165P	14	A.28
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U.S. Department of Energy Mary Walker, Assistant Secretary Environment, Health, and Safety	18	A.31

(a) Excerpt from transcript of public meeting.

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Ernest J. Sternglass, Ph.D. Professor Emeritus of Radiological Physics University of Pittsburgh School of Medicine	22	A.55(a)
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GPU Nuclear Corporation F. R. Standerfer, Director, TMI-2 4000-87-S-059 Document ID 0023P	30	A.42
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(a) Attachment to letter not reproduced.
(b) Attachment to letter from Encyclopedia Britannica not received.

MARYLAND
DEPARTMENT OF STATE PLANNING
301 W. PRESTON STREET
BALTIMORE, MARYLAND 21201-2365

HARRY HUGHES
GOVERNOR

CONSTANCE LIEDER
SECRETARY

January 8, 1987

Mr. William D. Travers
Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

State Identification Number: MD870107-0011

State Clearinghouse Contact: Samuel Baker

RE: Draft Supplement 2 to the Programmatic EIS -
Three Mile Island, Unit 2

Dear Mr. Travers:

This is to acknowledge receipt of the referenced subject. We will provide notice to the State and local public officials of the subject via the Intergovernmental Monitor. This will evidence conclusion of the Maryland Intergovernmental Review and Coordination Process (COMAR 16.02.03).

Thank you for your cooperation.

Sincerely,

Guy W. Hager
Director, Maryland State Clearinghouse
for Intergovernmental Assistance

GWH:SB:jp

TELEPHONE: 301-225-4490
TTY for Deaf: 301-383-7555
OFFICE OF STATE CLEARINGHOUSE

TORREY C. BROWN, M.D.
SECRETARY

JOHN R. GRIFFIN
DEPUTY SECRETARY

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
TAWES STATE OFFICE BUILDING
ANNAPOLIS 21401

January 30, 1987

Mr. William D. Travers, Director
TMI-2 Cleanup Project Directorate
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Travers:

I have received the Draft Supplement 2 to the Programmatic Environmental Impact Statement for disposal of radioactively contaminated water stored at the Three Mile Island Nuclear Station site. The Department of Natural Resources will provide comments on the draft report on behalf of the State of Maryland. The Power Plant Research Program (PPRP) will serve as lead agency. PPRP will conduct its own review and coordinate the comments of other interested Maryland agencies.

Sincerely,

Torrey C. Brown MD

Torrey C. Brown, M.D.

TB:ph

cc: Paul Massicot
William Eichbaum
Edward Murray
Guy W. Hager
Tom Andrews
Verna Harrison
David Carroll

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PDR ADOCK 05000320
D PDR

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1/0

Telephone (301) 974-3041

TTY for Deaf - Annapolis - 269-2609 D.C. Metro - 565-0450

Commonwealth of Pennsylvania
Department of Health
HARRISBURG
717-787-5264

January 27, 1987

Dr. William D. Travers
Director
TMI-2 Cleanup Project Directorate
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Travers: Bill

Thank you for sending to my office your Draft Supplement 2 to the Programmatic Environmental Impact Statement for disposal of radioactively contaminated water stored at the TMI nuclear station site.

As requested, I have review the draft document and provided a brief comment. This supplemental PEIS appears to be very thorough and well thought out. Please feel free to contact my office again regarding this and any other related matter.

Sincerely,

George K. Tokuhata, Dr.P.H., Ph.D.
Director
Division of Epidemiology Research

Attachment

P.O. BOX 90, HARRISBURG, PA [illegible]

DRAFT SUPPLEMENT 2 TO THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT - THREE MILE ISLAND, UNIT 2

Comment By

George K. Tokuhata, Dr.P.H., Ph.D.
Director
Division of Epidemiology Research
Pennsylvania Department of Health

My comments as an epidemiologist are confined to the realm of epidemiology, particular in those areas where potential health impacts exist. I am particularly interested in an estimate of the possible health effects resulting from radiation doses to the maximally exposed individual offsite, the general population, and the workers. Also there is a need to consider radiological health impacts resulting from spills and nonradiological impacts resulting from traffic accidents, injuries, and fatalities.

For all evaluated alternatives, the 50-year dose commitment to the maximally exposed individual dose ranges from 0 to 3 mrem to the bone and 0.00 to 0.53 mrem to the total body. These radiation doses are in addition to the approximately 87 mrem/year received by the average Harrisburg resident from natural background.

The population dose ranges from 0 to 11 person-rem to the bone and from 0 to 3 person-rem to the total body. The population doses from the atmospheric releases from onsite evaporation or solidification processes at TMI are distributed to a population of 2.2 million persons in the vicinity of TMI. The population also receives an annual background radiation dose of approximately 190,000 person-rem. Annually, 300,000 people will receive 26,000 person-rem from background sources.

Occupational dose estimates for all evaluated alternatives range from 0.5 to 25 person-rem. Essentially all of the external occupational doses received for all scenarios are due to other sources in the vicinity of the workers, not the accident-generated water.

In estimating potential health effects from both offsite and occupational radiation exposures as a result of the disposal of the accident-generated water, the staff used cancer and genetic risk estimators that are based on information compiled by the National Academy of Sciences Advisory Committe on the Biological Effects of Ionizing Radiation. The estimates of the risks to workers and the general public are based on conservative assumptions.

The risk of potentially fatal cancers in the exposed work-force population is estimated to be 0.003, i.e., the probability of one cancer death over the lifetime of the entire work force as a result of the disposal operation is about 3 chances in 1,000.

The risk of potential premature death from cancer to the average individual within 50 miles of the reactors from exposure to radioactive effluents from the disposal operation is much less than the risk to the maximally exposed individual. The staff estimates that less than 0.001 cancer deaths may occur in the exposed population. The staff also estimates that about 0.002 potential genetic disorders may occur in all future generations of the exposed population.

Based on updated information in this draft supplement, the staff concludes that the risks to the general public from exposure to radioactive effluents from any alternative are very small fraction of the estimated normal incidence of cancer fatalities and genetic disorders. This conclusion is valid. I also concur that the most significant potential impact associated with any disposal alternative is the risk of physical injury associated with transportation accidents (0.03 to 0.80 traffic fatalities).

January 21, 1987

BEST COPY AVAILABLE

Pennsylvania Intergovernmental Council
P. O. BOX [illegible] • HARRISBURG, PA [illegible]

March 3, 1987

Michael T. Masnik
Three Mile Island Cleanup Project Directorate
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Masnik:

Pennsylvania's Single Point of Contact under Executive Order 12372 (Intergovernmental Review of Federal Programs) has received copies of the Issuance of Draft Supplement 2 to the Programmatic Environmental Impact Statement - Three Mile Island, Unit 2. He distributed copies to several of our reviewing agencies; these agencies do not wish to comment on the EIS.

We appreciate the opportunity to review this document.

Sincerely,

Sandra L. Kline

Sandra L. Kline
Special Assistant
Intergovernmental Review Process

Strengthening Intergovernmental Relations and Public Decision-making in Pennsylvania

---

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203-1715

REPLY TO ATTENTION OF:

Planning Division

6 February 1987

Mr. William D. Travers, Director
TMI-2 Cleanup Project Directorate
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Travers:

Reference your letter of 29 December 1986, regarding the review of the Draft Supplement 2 to the Programmatic Environmental Impact Statement (PEIS) for disposal of radioactively contaminated water stored at the Three Mile Island Nuclear Station site. The comments provided below address the Corps of Engineers areas of concern, including direct and indirect impacts on Corps of Engineers existing and/or proposed projects, flood control hazard potentials, and permit requirements under Section 404 of the Clean Water Act.

There are no existing or proposed Corps of Engineers projects that would be affected by the work described in the Draft Supplement 2 to the PEIS.

The PEIS should include documentation of the effects on the flood plain and compliance with Federal, State, and local flood plain regulations, as appropriate.

Three Mile Island Nuclear Station, Unit 2, is located entirely within the boundaries of the 500-year flood plain. The PEIS does not address Executive Order (E.O.) 11988, Flood Plain Management, dated 24 May 1977, which is applicable to this review as several of the alternative disposal solutions occur on the flood plain. In accordance with the U.S. Water Resources Council "Flood Plain Management Guidelines For Implementing Executive Order 11988", (43FR 6030), 10 February 1978, the proposed actions may be considered critical such that even a slight chance of flooding would be too great. The document must evaluate alternatives with respect to E.O. 11988 and demonstrate that they have been designed to minimize adverse effects on the flood plain. If the selected alternative is to be located in the flood plain, it must be demonstrated to be the only practicable alternative.

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Each of the 10 alternative disposal methods were reviewed to assess potential impacts on the flood plain. Those alternatives which include total or partial on-site storage and/or treatment at Three Mile Island are subject to flood hazards which could reintroduce the contaminated material into the environment. The alternatives known to be susceptible to flood hazard are:

Alternative #1	Evaporation, solidification of bottoms, disposal at a licensed burial site.
Alternative #2	Evaporation, solidification of bottoms, and retention on-site.
Alternative #6	Permanent on-site storage of solidified waste.
Alternative #8	Long-term discharge into the Susquehanna River.
Alternative #9	Short-term discharge into the Susquehanna River.
Alternative #10	Liquid storage in tanks at the Three Mile Island site.

The risk of flood hazard is minimized by those alternatives which minimize the amount of time materials are stored on-site. The risk of reintroducing hazardous materials into the environment can also be minimized by adopting flood resistant design and construction methods for containers.

The alternatives listed below are not located at Three Mile Island, are not within the Baltimore District, and cannot be judged for susceptibility to flood hazards.

Alternative #3	Off-site evaporation at the U.S. Department of Energy (DOE) Nevada Test Site.
Alternative #4	Deep-well injection at the DOE's Nevada Test Site.
Alternative #5	Crib Disposal at the DOE's site in Hanford, Washington.
Alternative #7	Solidification and disposal at a commercial low-level waste site.

Under Section 404 of the Clean Water Act, Department of the Army authorization is required prior to any discharge of dredged or fill material into waters of the United States, including their associated wetlands. Since the proposed work does not involve work or placement of fill in waters of the United States, Department of the Army authorization is not required.

If there are any questions concerning this matter, feel free to call me or my action officer, Mr. Larry Lower, at (301) 962-4710.

Sincerely,

James F. Johnson

James F. Johnson
Chief, Planning Division

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A.10

TORREY C. BROWN, M.D.
SECRETARY

JOHN R. GRIFFIN
DEPUTY SECRETARY

STATE OF MARYLAND

DEPARTMENT OF NATURAL RESOURCES
ENERGY ADMINISTRATION
POWER PLANT SITING PROGRAM
TAWES STATE OFFICE BUILDING
ANNAPOLIS 21401
(301) 269-2261

February 24, 1987

Dr. Michael T. Masnik
TMI Project Directorate
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Draft Supplement No. 2 to the Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979 Accident Three Mile Island Nuclear Station, Unit 2 (NUREG - 0683)

Dear Dr. Masnik:

The above referenced document has been reviewed by various agencies of the State of Maryland. This transmittal provides collective comments on the subject document and reflects the State of Maryland's position regarding disposal of the accident-generated water.

Maryland concurs that disposal by any of the nine evaluated options would result in insignificant environmental or radiological impact given the radionuclide inventory and chemical constituency described. We also agree that liquid storage onsite (no-action alternative) provides no reasonable benefit and merely forestalls the disposal issue. It should receive no further consideration.

With regard to the licensee's proposal--forced evaporation and offsite disposal of evaporator bottoms--we have no objection to approval of this alternative by the Commission. It would appear however, that options involving bulk shipment offsite would result in a substantial savings in money and, more importantly, in time. Adoption of one of these alternatives would seem to better serve the cause of expediting the TMI-2 cleanup, a desire expressed by consensus. The draft supplement notes that Department of Energy (DOE) approval is necessary for implementation of elements within bulk shipment options or forced evaporation. However, there is no discussion of DOE's willingness to accomodate the licensee's proposal or their preference among the alternatives. It would seem that the next logical step would be NRC solicitation of DOE approval for options which require their participation, advisement of which would dictate the range of remaining alternatives. Only after this interaction can the Commissioners review the licensee proposal and evaluate its merits relative to bulk shipment alternatives.

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Although we agree with the Commission that the environmental and radiological consequences associated with disposal of the accident-generated inventory are trivial, we are opposed to implementation of either of the two options which result in releases to the Susquehanna River. The degree of perceived risk and public opposition to a river discharge remains high. This fact was recognized by the licensee in their proposal, and influenced their selection of another alternative. We acknowledge the Commission's awareness of this sustained sensitivity and encourage consideration of this fact in the evaluation and approval of a disposal alternative.

The State of Maryland offers no substantive comments on form or content other than those indicated above. We appreciate the opportunity to review the document and provide these comments.

Sincerely,

Richard I. McLean
Administrator, Radioecology
Power Plant Research Program
Department of Natural Resources

RIM/rva

cc: David Carroll, Assistant to the Governor

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United States Department of the Interior

OFFICE OF ENVIRONMENTAL PROJECT REVIEW
WASHINGTON, D.C. 20240

ER 87/86

MAR 1987

William D. Travers, Director
TMI-2 Cleanup Project Directorate
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Travers:

The Department of the Interior has reviewed draft supplement 2 to the programmatic environmental statement related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979 accident at Three Mile Island Nuclear Station, Unit 2, Dauphin County, Pennsylvania, and has the following comment.

The draft supplement to the programmatic environmental statement indicates plans to monitor ground water, both upgradient and downgradient from possible sources of contamination. We suggest that the analysis should also discuss plans for mitigation measures to be undertaken in the event that movement of pollutants in ground water is detected.

Sincerely,

Bruce Blanchard, Director
Environmental Project Review

501 Vine Street
Middletown, PA 17057
March 3, 1987

Mr. Michael Masnik
TMI Project Directorate
Office of Nuclear
Reactor Regulation
USNRC
Washington, DC 20555

Dear Mr. Masnik:

The fate of the accident generated water should be tied very closely to concerns of the population and the actual need to dispose of the liquid at this time.

Contrary to some opinions, I believe the competence and integrity of GPU must always be questioned. Why should they be allowed to do anymore then concentrate on the very delicate decon and defuel job at Unit 2? After all the basement of Unit 2 will likely not be completely cleaned until the 21st century. Why have GPU spend its fiscal and worker resources on a 12 million dollar operation never before completed at a civilian reactor site and in particular since there are no medical studies that state GPU's preferred method is safe?

I note the "errata sheet" of the NRC document (NUREG - 0683, Supplement 2) has several computational errors which could relate to human health. A study completed during Krypton 85 venting of 1980 contradicted NRC estimates of human exposure to that "assault" on area residents. Pages A-173 to A-180 of NUREG - 0683 Final Programmatic Environmental Impact Statement Vol. 2 Appendices A - Z March 1981 detail a history that we should certainly consult. This report deals with the venting of Kr 85 and other contaminants from June 28 to July 11, 1980 at TMI 2. Basically the Report says 4 million times the Strontium 90 greater then published predictions was vented which calculated to human life lost due to cancer. The same Nureg discusses annual releases of tritium at 300 curies.

I ask where else has this technique which GPU wants to do as a "public service" been completed and assessed as to the effects on the residents?

Yes, I know Unit 1 is emitting radioactive water and gasses as does Unit 2 but once again I come to competence, trust and integrity. Let GPU concentrate on decon and defuel work.

GPU should use its monitoring and engineering expertise to be sure storage of the contaminated water will remain in tanks on site. I propose GPU spend 2 million dollars for state of the art tanking with reserve capacity. This would allow them to apply the 10 million

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dollars (Forced evaporation costs 12 million) saving to working on the radioactive basement in Unit 2. I believe they will exceed 1 billion dollars on the entire decon/defuel job, so let's not waste 12 million dollars on another experimental system.

Let GPU demonstrate their expertise at monitoring the safe storage of the contaminated water while spending more valuable time, money and worker resources on the serious problem of decon/defuel work inside Unit 2.

With sincerity,

Donald E Hossler

Donald E. Hossler

A.12

CATHERINE I. RILEY
34TH LEGISLATIVE DISTRICT
HARFORD COUNTY

FINANCE COMMITTEE
CHAIRMAN

SENATE OF MARYLAND
ANNAPOLIS, MARYLAND 21401-1991

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302 JAMES SENATE OFFICE BUILDING
PHONE 841-[illegible]

February 9, 1987

Mr. William D. Travers
Director, TMI-2 Cleanup Project Directorate
Post Office Box 311
Middletown, PA 17057

Dear Mr. Travers:

I received a copy of the Programmatic Environmental Impact Statement Related to Disposal of Accident-Generated Water. I support the disposition of the water by evaporation, solidification of bottoms, and transfer of solids.

I oppose both the long term and short term discharge to the Susquehanna River for the following reasons:

a. Accidental discharge of the water before it has been retreated.

b. Impoundments in the river that would hold up and retain the accident generated water in the vicinity of river intakes for weeks.

c. A downstream water intake not closed during the passage of the water.

d. Cumulative effects with Peak Bottom water.

e. Potential damage to marketability of Chesapeake Bay seafood.

I am also uncomfortable with the growth and regrowth of the micro-organisms. I am not convinced that an "ordinary river micro-organism" remains so after it has been exposed to radiation for an undetermined amount of time.

I appreciate the NRC's concern and care exhibited throughout the past almost eight years. Please don't jeopardize the situation at this date. Your continued cooperation is deeply appreciated.

Sincerely,

Catherine I. Riley
Senator

CIR/dm

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NCRP

National Council on Radiation Protection and Measurements

7910 WOODMONT AVENUE SUITE 1016 BETHESDA MARYLAND 20814-3095 AREA CODE (301) 657-2652

WARREN K. SINCLAIR, Ph.D. President
S. JAMES ADELSTEIN, M.D. Vice President
W. ROGER NEY, J.D. Executive Director

February 23, 1987

Dr. Michael Masnik
P320
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Masnik:

In response to your request for comment on the supplement to the "Final Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979, Accident at the Three Mile Island Nuclear Station, Unit 2," the National Council on Radiation Protection and Measurements is pleased to proffer its Commentary No. 4, "Guidelines for the Release of Waste Water from Nuclear Facilities with Special Reference to the Proposed Release of Treated Waste Waters at Three Mile Island." I hope that this will prove helpful to the Commission in dealing with the important problem of disposal of the contaminated waste water at the Three Mile Island facility.

Sincerely yours,

Warren K. Sinclair

Warren K. Sinclair
President

WKS/mc

Enclosure

A NON-GOVERNMENT NOT-FOR-PROFIT CONGRESSIONALLY CHARTERED PUBLIC SERVICE ORGANIZATION

Corrected

NCRP COMMENTARY No. 6

GUIDELINES FOR THE RELEASE OF WASTE - WATER FROM NUCLEAR FACILITIES WITH SPECIAL REFERENCE TO THE PUBLIC HEALTH SIGNIFICANCE OF THE PROPOSED RELEASE OF TREATED WASTE WATERS AT THREE MILE ISLAND

National Council on Radiation Protection and Measurements
7910 Woodmont Avenue, Bethesda, Maryland 20814

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Preface

In May of 1980, the NCRP issued a report entitled, Krypton-85 in the Atmosphere - With Specific Reference to the Public Health Significance of the Proposed Controlled Release at the Three Mile Island, in response to public concerns over the proposed venting of Krypton from TMI-2. That document was prepared in response to a request from Governor Thornburgh of the Commonwealth of Pennsylvania and as part of NCRP's responsibilities as stated in its congressional charter. The charter includes, among other things, the responsibility to "collect, analyze, develop and disseminate in the public interest, information and recommendations about (a) protection against radiation and ...". The study was also recognized as part of the general problem of controlling releases to the atmosphere of which the circumstances at TMI-2 were a special case.

The problem of releases of waste water from TMI-2 could raise similar scientific and public issues. Again, TMI-2 is a specific case of a general problem.

In 1980, the Nuclear Regulatory Commission requested the NCRP to examine this issue. Recognizing that it could serve the public interest, the Council established a Task Group to address this problem. The Task Group prepared a draft report which was reviewed by the Council in 1985. The members of the Task Group were:

Frank L. Parker, Chairman
Vanderbilt University
Nashville, Tennessee

Members

A. Bertrand Brill
Brookhaven National Laboratory
Upton, New York

Bernd Khan
Georgia Institute of Technology
Atlanta, Georgia

Donald G. Jacobs
Roy F. Weston, Inc.
Oak Ridge, Tennessee

Edward Watson
Battelle Pacific Northwest Laboratories
Richland, Washington

However, further proposals to release the waste water at TMI-2 have been developed recently by GPU Nuclear. Therefore NCRP established a new Task Group to review the potential environmental impacts of these proposals.

The U. S. Nuclear Regulatory Commission have reserved to itself the decision on disposal of the waste water. As part of this process, NRC issued a "Final Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979, Accident Three Mile Island Nuclear Station, Unit 2" in 1981. A supplement to the EIS is now out for public comment. This Commentary is intended to provide the NCRP's response to the request for public comment.

The System International (SI) units are used in this report but, with the exception of Section 5 are followed by the conventional units in parenthesis in accordance with the procedure set forth in NCRP Report No. 82.

Serving on the Task Group during the preparation of this Commentary were:

Charles B. Meinhold, Chairman
Brookhaven National Laboratory
Upton, New York

Members

Leonard Emma
Brookhaven National Laboratory
Upton, New York

Donald G. Jacobs
Roy F. Weston, Inc.
Oak Ridge, Tennessee

William L. Templeton
Battelle Pacific Northwest Laboratories
Richland, Washington

John E. Till
Radiological Assessments Corporation
Neeses, South Carolina

Consultants

Victor P. Bond
Brookhaven National Laboratory
Upton, New York

Melvin W. Carter
Georgia Institute of Technology
Atlanta, Georgia

John W. Healy
Los Alamos, New Mexico

Frank L. Parker
Vanderbilt University
Nashville, Tennessee

NCRP Secretariat - E. Ivan White

The Council wishes to express its appreciation to the Task Group members and consultants for the time and effort devoted to the preparation of this Commentary.

Warren K. Sinclair
President, NCRP

Bethesda, Maryland
February 25, 1987

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1. Introduction

The risk associated with the release of waste water from nuclear facilities, whether generated by accident or produced during "normal" operations, is of interest to the public and the nuclear industry. The presence of waste water at Three Mile Island (TMI) and proposals for its release represent a special case of this problem, the analysis of which is widely applicable.

In many situations, including the case at TMI, the radionuclides other than tritium can be removed from the waste water by various processes. Tritiated water cannot be separated and concentrated from ordinary water by conventional waste treatment techniques (Blomeke, 1964). Isotopic separations are available, but these are impractical for high volume, low concentration operations (IAEA, TRS, 234-1984). Thus, while radionuclides other than tritium can be removed from contaminated waste water, the tritium must be handled by other means. Therefore, the focus here is primarily on the disposal of tritiated waste water.

Because of the previous work on this subject by the NCRP, it is possible to apply existing knowledge and procedures to the situation at TMI.

The National Council on Radiation Protection and Measurements (NCRP) in 1979, published NCRP Report No. 62, Tritium in the Environment (NCRP, 1979). That report dealt with the available information on tritium in terms of its physical properties, production sources, physical transport, biological behavior, projected future production, waste management and long-term implications in the environment.

The Council, in 1984, published NCRP Report No. 76, Radiological Assessment: Predicting the Transport, Bioaccumulation, and Uptake by Man of Radionuclides Released to the Environment (NCRP, 1984). That report dealt with a review of the current status of the application of radionuclide transport models from the point of discharge to the environment to the point of intake by man. Models are reviewed that describe the transport of radionuclides through the atmosphere, surface and groundwater, deposition on terrestrial surfaces and in sediments and accumulation in food products. Usage factors are considered that determine the intake of radionuclides by humans due to dietary habits, physiological parameters and living customs.

The information provided in the two cited NCRP reports is used in the analysis here of the public health significance of the disposal of waste water contaminated with tritium. Optional methods for release of tritiated waste water are reviewed, information about tritium provided, and environmental transport and pathways are examined and dosimetry discussed. Finally, doses and health effects resulting from waste water releases are given.

2. Status of Accident Generated Waste Waters at Three Mile Island

The TMI-2 accident resulted in the production of large volumes of contaminated water. Since the time of the incident, the total inventory of this water has increased to approximately 1.9 million gallons due to continued inleakage from support systems and condensation from the Reactor Building air coolers. The specific sources of the waste water and their quantities of radionuclides are given in Appendix A. When the clean-up is completed in

A.16

October, 1988, it is estimated that approximately 2.[illegible] million gallons of water will require disposition. In addition to tritium, the principle radionuclides present are ^{60}Co, ^{90}Sr, ^{125}Sb, ^{134}Cs, and ^{137}Cs. GPU Nuclear has noted (GPU, 1986) that prior to ultimate disposition, a considerable amount of this water will require processing to reduce the levels of radioactive contaminants. This reduction of the radionuclide levels will minimize the total release of activity, particularly of ^{90}Sr, to the environment and thereby minimize the environmental consequences associated with the various disposal options.

The volume of water requiring processing prior to ultimate disposal depends upon the selection of the final disposal method. Three methods have been considered (see Section 3) - - river discharge, direct solidification and evaporation. For the "river discharge" and "direct solidification" options, essentially all of the water would require initial processing, or reprocessing, through existing ion exchange systems prior to disposal. This is referred to as 100% processing. In light of the decontamination factor achieved by evaporation, it is estimated that only about 40% of the total volume will require reprocessing to reduce the activity levels before final disposal by the release to the atmosphere. This is referred to as 40% processing. The average characteristics of the water expected after these two degrees of processing are presented in Table 2.1.

The boron concentration in the water is given in Table 2.1. Boron may influence the disposition options either through discharge limits to the environment (via the federally mandated release limit of 25 ppm boron), increased quantities of concentrates requiring solidification from the evaporation option, or the necessity to add stabilizing agents to ensure proper solidification. In addition, the water will contain approximately 11 tons of sodium hydroxide.

Table 2.1 - Pre-disposition water characteristics

40% Processing	Tritium	^{137}Cs	^{90}Sr	Boron	Sodium
Concentration Bq/m^3 (µCi/ml)	$4.8x10^9$ $(1.3x10^{-1})$	$1.37x10^3$ $(3.7x10^{-5})$	$4.3x10^3$ $(1.15x10^{-4})$		
Total Activity Bq (Ci)	$3.77x10^{12}$ (1020)	10^9 (.29)	$33x10^9$ (.9)		
Concentration ppm				3,000	700
Total Quantity Tons				150 As H_3BO_4	11 As NaOH
100% Processing					
Concentration Bq/m^3 (µCi/ml)	$4.8x10^9$ $(1.3x10^{-1})$	$1.5x10^5$ $(4x10^{-6})$	$3.7x10^4$ $(1x10^{-5})$		
Total Activity Bq (Ci)	$3.77x10^{12}$ (1020)	$1x10^9$ (.03)	$3x10^9$ (0.08)		
Concentration ppm				3,000	700
Total Quantity Tons				150 As H_3BO_4	11 As NaOH

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3. Options For Treatment Of Tritiated Waste Water from Three Mile Island

In the July, 1986, Report, "Disposal Of TMI-2 Water," (GPU, 1986) GPU Nuclear proposed three disposal options for the processed waste water. These options are as follows:

1. Evaporation - Processing and evaporation of the water would be by an installed evaporation facility followed by controlled atmospheric release. Shipment to, and disposal of, solidified residues at a licensed, commercial low-level waste disposal site would follow.
2. Solidification - Processing and solidification of the water in cement would be followed by burial in an on-site industrial landfill.
3. River Discharge - Processing and controlled, monitored discharge to the Susquehanna River would result in significant dilution of the processed water.

The GPU Report noted that direct release to the river is the best choice on the basis of overall technical merit but that political and institutional concerns resulted in their suggesting the evaporation/atmospheric release option as the method of choice. We therefore reviewed the potential impacts of evaporation/atmospheric release option given above slightly modified to ensure that the dose from other radionuclides are appreciably less than those from tritium (see Appendix B). The decision to imploy such a modification in our analysis was based on the unique difficulty of removing tritium from waste water, the comparatively low radiogenic hazard associated with tritiated water, and the ease and precision of tritium environmental transport analysis. One could reasonably argue, however, that in view of the extremely low doses involved, use of this approach is unnecessarily conservative. Since this analysis also suggested that the addition of an evaporation step might improve the viability of the River base option we analyzed this scenario as well.

We have not, however, assessed the solidification option since the GPU Report suggested that it had the lowest overall merit of the three options.

3.1 Evaporation/Atmospheric Release

This option employs a standard industrially available evaporation unit which, depending on the available decontamination factor, would require preprocessing of between 40% and 100% of the waste waters (see Appendix B). The vapor produced by the evaporator, which contains essentially all of the tritium, would be released through a 50-meter stack. If a typical processing rate of 3 gallons per minute is assumed and the operating basis is seven days a week, with two, ten-hour shifts per day of actual processing with an overall availability of 80%, approximately two years would be required to process the total volume of waste water (2.1 million gallons). This option would result in a release rate of .93 MBq/sec (25 uCi/sec) or approximately 19.5 TBq/yr (526 Ci/yr) of tritium to the atmosphere.

3.2 Evaporation/Surface Water Release

This option employs the evaporation step followed by controlled release of the condensed vapors to the Susquehanna River. Again, the extent of required preprocessing of input waste waters would depend on the efficiency of the particular evaporator used. In any case, as shown in Appendix B, the evaporation step will ensure that the ^{90}Sr source [illegible] compared to that for tritium.

After evaporation, rather than releasing to the 50 meter stack, all the vapor would be condensed and pumped to one of the two 11,000-gallon condensate test tanks. From these tanks the water would be discharged to the Susquehanna River via blow down from the mechanical draft cooling tower. The use of the cooling tower blow down in this manner provides a dilutant flow of about 22,000 gallons per minute. Use of this option would also result in a release of 19.5 Bq/yr (526 Ci/yr).

For either the "Evaporation/Atmospheric Release" or the "Evaporation/Surface Release" option, disposal of the waste water will require approximately two years.

4. Tritium - Physical and Chemical Properties

Tritium is the heaviest and only radioactive isotope of hydrogen. It was discovered in 1939 by Alvarez and Cornog (1939) who determined that it emitted radiation with a very short range and had a long half-life; subsequent work established that it decays with a half-life of 12.3 years. It emits a beta particle with a maximum energy of 18 keV and an average energy of 5.7 keV to form ^{3}He.

Tritium is produced naturally by the interaction of cosmic rays with elements in the upper atmosphere. It is also produced by thermal or fast neutron reactions with various light elements utilized in reactors, such as boron, used for reactivity control, and lithium, used for corrosion control. Tritium formed in this way is circulated in the coolant and from there is released into the environment. Most of the fission product tritium is normally retained within the fuel element cladding, however, an appreciable fraction of the fission product tritium can be released from the fuel elements when the core is damaged such as in the case of TMI-2.

For a detailed review of the physical and chemical properties of tritium, see NCRP Report No. 62 (NCRP, 1979). Tritium closely follows the reactions of ordinary hydrogen, although, the relatively large mass differences among the hydrogen isotopes make isotopic effects discernible. Because of the prevalence of water and its importance in the life processes, the isotopic exchange of hydrogen in water with tritium is of special importance.

In the environment, tritiated water behaves generally, though not exclusively like ordinary water. Most of the predicted behavior of tritium is based on existing information regarding the cycling of water, supplemented by observations of the behavior of tritium produced during atmospheric testing of nuclear weapons. Tritium can also become an integral part of any chemical compound containing hydrogen atoms, including the organic compounds that make up living tissue.

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5. Tritium - Environmental Transport and Pathways of Exposure

5.1 Assessment of Releases to the Atmosphere

When tritium is released to the atmosphere, it disperses rapidly and mixes with stable hydrogen in the atmosphere, hydrosphere and biosphere. Tritium released in forms other than tritiated water (HTO), tends to convert to HTO. Concentrations of tritium in atmospheric water at a given distance and direction from a source are typically estimated using atmospheric dispersion models as described in NCRP Report No. 76 (NCRP, 1984) and the absolute humidity for the point of interest. For purposes of assessing dose from tritium released to the atmosphere, it is generally assumed that the chemical form is HTO and that there is uniform mixing between atmospheric water vapor and the bound and unbound hydrogen in biological systems. This approach, referred to as the specific activity method, is based on data reported by Evans (1969) that suggests that body hydrogen is uniformly labeled with tritium under chronic exposure conditions. Although other approaches, such as the multicompartment model, may lead to more precise estimates of dose, the specific activity method is simpler to apply and generally results in dose estimates that are significantly higher than those which would actually exist. Therefore, if acceptable criteria for exposure are met as determined using this more conservative but simpler approach, use of a more sophisticated model may not be justified. This is especially true since the application of a multicompartment model requires the use of site specific compartment dilution volumes and intercompartment transfer rates. The use of a simple effective model in preference to a more complex model is in accordance with previous NCRP Recommendations (NCRP, 1984).

A model based on the specific activity method and the contribution to total water intake of reference man was proposed by the NCRP (1979, 1984). The model predicts that the relative importance of different pathways of exposure is determined by the intake of body water derived from each pathway. This model was updated by Killough (1982) to balance total hydrogen intake, accounting for hydrogen in both water and organic products consumed by individuals. The model of hydrogen balance assumed for reference man allows one to convert tritium specific activities in food and fluids and in the individual's ambient air to daily intake rates for steady-state conditions as described below

$$\underline{I}_{air} = (15 + 9)\ \underline{A}_{air} \qquad \text{(TBq/d)} \qquad (5.1)$$

$$\underline{I}_{ingestion} = 183\ \underline{A}_{water} + 33\underline{A}_{milk} + 120\underline{A}_{food} \qquad \text{(TBq/d)} \qquad (5.2)$$

where $\underline{I}_{air}$, and $\underline{I}_{ingestion}$, are the intakes via air and ingestion, respectively. The specific activities $\underline{A}_{air}$, $\underline{A}_{water}$, etc. are in units of terabequeral per gram of hydrogen (TBq/gH) and the coefficients are grams of hydrogen per day (gH/d) derived from the data on hydrogen intake and losses given for ICRP's Reference Man (ICRP Publication 23) as modified by Killough and others (Killough, 1982). Note that water in food is included in the coefficient 120 associated with $\underline{A}_{food}$ in Eq. 5.2. It is also important to note that the coefficients 15 and 9 in Eq. 5.1 (inhalation and absorption through the skin) are sensitive to the ambient absolute humidity, and the values given here correspond to an ambient absolute humidity of 6 $gH_2O\ m^{-3}$. The specific activities $\underline{A}_{water}$, $\underline{A}_{milk}$, and $\underline{A}_{food}$ depend on the environmental sources of the water, milk, and food ingested by the reference individual.

Based on information given in ICRP Publication 23 (ICRP, 1975) as updated by Killough (1982), it is assumed that the total hydrogen intake is 360 gH/d. The hydrogen balance model for assessing dose from tritium in the environment can be described as follows:

$$(15 + 9)\, A_{air}\ DCF_{inhalation} + (183 A_{water} + 33 A_{milk} + 120 A_{food})\, DCF_{ingestion}\quad 365\ d/y \qquad (Sv/y) \qquad (5.3)$$

where,

A_{air}, A_{water}, etc. = specific activities of tritium in air, water etc. (TBq/gH), and

$DCF_{inhalation}$, $DCF_{ingestion}$ = dose conversion factors for tritium by inhalation and ingestion which have values of 2.2 Sv/TBq and 23 Sv/TBQ, respectively.

The model can be further subdivided to account for different concentrations of tritium present within a given pathway. For example, it is frequently assumed that individuals drink water from several sources, each containing different concentrations of tritium. If this level of detail is desired in the calculation, then the ingestion of tritium can be determined by calculating the relative intake from each source.

The specific activity methodology assumes that for a given location, the concentration of tritium is the same in atmospheric water and biota. This assumption likely leads to a higher estimate of dose than that which actually occurs because it is unusual for a steady state condition to exist in the environment near a source, considering the intermittent nature of most source terms and the variability of meteorological and climatic conditions. Assuming the specific activity of tritium in each component (i.e., air, water, milk, and food) were the same, the model tells us that intake of tritium via ingestion of water and food are the most important pathways of exposure. The contribution to dose from inhalation and skin absorption combined when all pathways of exposure are available, is approximately 7%.

It is likely that this technique significantly overestimates the dose from tritium to individuals who do not produce and consume their own food products but import them from regions, outside their area, where tritium concentrations in food are substantially lower. Likewise, persons may receive only a fraction of their drinking water supply from a source containing tritium. Nevertheless, this simple model can be easily applied to estimate dose at a given distance from the source once the concentration of tritium in atmospheric water at that location is derived using a meteorological model.

One key to applying this model is the determination of the concentration of tritium in drinking water when the only source of release is to the atmosphere. When the release of HTO is to the atmosphere, it is generally assumed that the concentration of tritium in drinking water is 1% of that in air for a given location (NCRP 1984). This assumption is simply an attempt to account for tritium that migrates from the atmosphere to drinking water supplies. If a drinking water supply is known to contain tritium from another source, then this assumption is no longer valid and the concentration in drinking water must be determined.

5.2 Assessment of Releases to Surface Water

Tritium released to water in the environment is assumed to be HTO. Complete mixing will ultimately occur. However, the time to achieve complete mixing and the location and steady state concentration where complete mixing occurs depends on the site specific characteristics of the body of water receiving the release. Mathematical models describing methods for determining the dispersion of tritium in surface water are discussed in NCRP Report No. 76 (NCRP, 1984). As with releases of tritium to the atmosphere, the first step in determining the dose from tritium released to surface water is to calculate the concentration in water at the point of interest where water is being consumed.

The pathways of exposure available to humans following a release of tritium to water are drinking water and foods irrigated by that water. The model described in Eq. 5.3 can be applied to estimate dose and, for simplicity, the tritium to hydrogen ratio in food due to irrigation is assumed to be equal to that in drinking water. The contribution to dose from tritium in the atmosphere is assumed to be negligible.

6. Dosimetry

As shown in Eq. 5.3 estimates of dose due to tritium are made by multiplying the activity ingested or inhaled by the Dose Conversion Factor (DCF). For a given intake mode (ingestion, inhalation, or absorption through the skin), a dose conversion factor for any radionuclide is the committed dose equivalent to a specified organ per unit intake of the radionuclide. In lieu of an organ-specific dose conversion factor, one may also consider the committed effective dose equivalent, which is the weighted average of organ-specific DCF's, with weights proportional to risks associated with stochastic fatal health effects, as defined by the International Commission on Radiological Protection (ICRP, 1977).

Killough (1982) reviewed the dosimetry for tritium in tissue following intake by ingestion, inhalation, and skin absorption and calculated dose conversion factors. An intake of HTO either by ingestion or inhalation is generally assumed to be completely absorbed and to mix uniformly with the water content of the body. For most organs and tissues, the average emitted beta-ray energy of 5.685 keV is treated as if it were completely absorbed within the organ containing the radionuclide (the source organ). Exceptions to this are transfers of energy among skeletal tissues that are treated as discrete targets (endosteal cells, red marrow) and from the contents to the walls of the gastrointestinal tract. A quality factor (Q) of 1 is used in the derivation of dose conversion factors for tritium.

Exposure to contaminated atmosphere results in complete uptake of inhaled HTO and its absorption through intact skin at a comparable rate. Pinson and Langham (1957) estimated that the rates were equal, and results of a study reported by Osborne (1966) suggest that absorption through the skin accounts for 60% of the total uptake rate when inhalation and skin absorption are the only two modes of exposure. The reader is reminded, however, that because of the ubiquitous nature of tritium following a release to the atmosphere, all modes of exposure are likely, including ingestion, inhalation, and skin absorption, and that the ingestion pathway likely dominates since that pathway is the primary mode of entry of hydrogen into the body.

Biological removal of tritium from the body occurs through urination, fecal excretion, sweat, exhalation, and insensible loss through the skin. Killough (1982) derived organ-specific dose conversion factors using a dynamic compartment model based on hydrogen balance in reference man and equilibrium of specific activities between body water and other tissues. Killough's data indicate that there is little difference between the dose conversion factors for intake of tritium by ingestion and inhalation or skin absorption.

7. Dose Equivalents Resulting from Release of Tritiated Waste Water to the Atmosphere and Surface Water at Three Mile Island

7.1 Assessment of Tritium Releases to the Atmosphere

In the case where the waste water is decontaminated and tritium is released to the atmosphere as HTO, it is assumed that the tritium will mix with the water in air and with water in the environmental media in the vicinity of the point of release. The source term for tritium release to atmosphere in this case is estimated to be 19.5 TBq/y (526Ci/y). It is assumed that the release rate is approximately constant throughout the year.

Dispersion parameters (X/Q) for the TMI Nuclear Station have been previously calculated based on the average annual meteorological conditions for the facility (USNRC, 1981). The maximum hypothetical dose from tritium would occur at the point having the highest dispersion parameter and where food products are grown. From the Environmental Impact Statement (NRC, 1981), we find this point to be 1.7 km (1.05 miles) east of the release point and an associated dispersion parameter of 2.13×10^{-6} s/m^3. Using this information, an upper limit estimate of the dose to a hypothetical individual residing at this point may be determined as follows:

The concentration of tritium in air at the point of interest is calculated by multiplying the source term by the dispersion parameter to give 1.3×10^{-12} TBq/m^3 (3.5 pCi/m^3). This value represents the average concentration of HTO in atmosphere at the point where maximum exposure occurs. In order to apply the models in Section 5, however, this concentration must be converted into TBq/gH. This is accomplished by assuming the average specific humidity in the area is 6 gH$_2$O/m^3 (NCRP, 1984) and correcting for the atomic weight of hydrogen in water. The result gives an activity concentration of tritium of 2.0×10^{-12} TBq/gH (54 pCi/gH) in air at the point of interest. Since tritium is not concentrated above ambient levels by biological media, it is reasonable to assume that tritium hydrogen ratios in food products grown at the point approach that in the ambient air. This bounding assumption also yields a higher estimate of dose than what actually occurs because it is most unlikely that all of the individuals food products would be grown in the area where maximum concentrations exist. Further, as stated in Section 5, it is assumed that the concentration of tritium in water being consumed by the individual is 1% of that in air at the point of interest. Applying these assumptions to the model described in Section 5 for atmospheric releases, the upper limit of the effective dose equivalent rate to a hypothetical individual is calculated to be 3.0 uSv/y (0.3 mrem/y) and the upper limit of the total effective dose equivalent commitment is calculated to be 6 uSv (0.6 mrem) for complete disposal of the waste water over a two-year period. A breakdown of contributions to effective dose equivalent by pathway indicates that food ingestion accounts for 67%, milk ingestion 18%, inhalation and skin absorption 13%, and drinking water 1%.

7.2 Assessment of Tritium Releases to Surface Water

If the decontamination process releases tritium as HTO to river water rather than to air, it is assumed that the HTO mixes completely with the river water. The source term for tritium release is given as approximately 19.5 TBq/y (526 Ci/y) in 84 m^3/min (2.2 x 10^4 gal/min). It is assumed that this release rate is constant throughout the year.

Dispersion in the Susquehanna River is estimated by assuming a flow rate of 9.7 x 10^2 m^3/s (3.4 x 10^4 ft^3/s) averaged over a year (USNRC, 1981). Assuming complete mixing of river water downstream of the discharge point where consumption occurs, the steady state concentration of tritium in river water from the waste water treatment process is 6.4 x 10^{-10} TBq/m^3 (17 nCi/m^3) or 5.8 x 10^{-15} TBq/gH (.15 pCi/gH). (This assumption is a simplification suggested by the statement given in the Environmental Impact Statement (USNRC, 1981) that "below York Haven Dam additional mixing occurs and the full flow of the river may be used in determining dilution factors.")

The effective dose equivalent can be estimated using the model described in Section 5 and making assumptions to simplify the analysis. It is assumed that the concentration of tritium in drinking water and all food, including aquatic food, and milk equals the concentration of tritium in the river. The only feasible mechanism for tritium in food to have the same concentration as that in river water is by assuming all food is derived from a source where irrigation is the only water source for the food crop. Although this assumption is highly unrealistic for the TMI area, it is consistent with other conservative assumptions made in this assessment. The concentration of tritium in air is assumed to be zero when the release is to surface water.

Applying these assumptions to the model in Section 5, the effective dose equivalent rate is calculated to be 0.01 μSv/y (1. μrem/y) and total effective dose equivalent commitment is calculated to be .02 μSv/y (2 μrem) for complete disposal of the waste water over a two-year period. These estimates are, as before, for a highly hypothetical individual. The contribution to effective dose equivalent commitment from the various pathways is as follows: 54% drinking water; 36% food; and 10% milk.

8. Summary of Health Effects and Conclusions

It is emphasized that due to the very conservative assumptions made to simplify this assessment, the estimated effective dose equivalents are upper bounds and it is highly unlikely that a person exposed to tritium released during the waste water clean up would receive doses approaching these values. Table 8.1 summarizes the assumptions made to estimate the effective dose equivalents and Table 8.2 summarizes the results for releases to atmosphere and to surface water. The estimated effective dose equivalents resulting from each method of release are likely much higher than anyone would realistically receive, and either pathway would result in radiation doses that are well within acceptable limits.

In view of the low level of effective dose equivalent calculated for the maximally exposed hypothetical individual, detailed calculations of collective dose equivalents are not warranted.

In this Commentary, for the purposes of assessing the health impacts of ingesting and inhaling tritium, it is assumed that a uniform whole body dose equivalent of 1 Sv (100 rem) will result in an average lifetime fatal cancer risk plus severe genetic risk of approximately 2×10^{-2}.

These risk values reflect current estimates of the ICRP (ICRP, 1977), but do not account for potential changes that may result from the re-evaluation of the Japanese atomic bomb survivor data. In addition, the quality factor of 1 for tritium beta radiation used in this Commentary is under review. However the net effect of both of these reviews is unlikely to result in an increase of the risk values by an order of magnitude.

Applying the risk estimates given above to the effective dose equivalent values given in Table 8.2 we find that the release to atmosphere option will result in a lifetime cancer plus severe genetic risk to the most highly exposed hypothetical individual of approximately 1 chance in 10 million.

The release to surface water option will result in a lifetime cancer risk plus severe genetic risk of approximately 1 chance in 1000 million to the most highly exposed hypothetical individual.

Since these risks are both below the Negligible Individual Risk Level of 10^{-7}/y recommended by the NCRP, and below the risk associated with one day of natural background, the health and safety of the public will be unaffected by the release of the treated waste waters from TMI-2 and therefore either option is acceptable.

Table 8.1 - Assumptions made for calculating tritium releases to atmosphere and surface water and estimating effective dose equivalents for clean up of TMI waste water

Release to Atmosphere	Release to Surface Water
Dispersion calculated using highest χ/Q for point 1.7 km (1.05 mi) east of site	Uniform mixing in river water with a flow rate of 9.7×10^2 m^3/S 34,000 ft^3/s averaged over a year
Concentrations of tritium in air, food, and milk are equal	All food products including aquatic foods have same tritium concentration as river water
Individual consumes only food grown locally	All drinking water comes from the river
Concentration of tritium in drinking water is 1% of that in air	No inhalation pathway exists

Table 8.2 - Summary of effective dose equivalent commitments resulting from two modes of release

Release to Atmosphere		Release to Surface Water	
	Effective Dose Equivalent Commitment		
Total	6.0 µSv (0.6 mrem)		0.02 µSv (2 µrem)
Pathway			
Food (67%)	4 µSv (0.4 mrem)	Food (36%)	0.007 µSv (0.7 µrem)
Milk (18%)	1 µSv (0.1 mrem)	Milk (10%)	0.002 µSv (0.2 µrem)
Inhalation (13%)	0.8 µSv (0.08 mrem)	Inhalation (0%)	0 µSv (0 µrem)
Drinking Water (1%)	0.06 µSv (0.006 mrem)	Drinking Water (54%)	0.011 µSv (1.1 µrem)

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Appendix A. Specific Sources of Waste Water at Three Mile Island[a]

				TOTAL RADIOACTIVITY					
STORAGE	DESCRIPTION	VOLUME GALLONS	DATE	H-3 Ci	Sr-90 Ci	Cs-137 Ci	Cs-134 Ci	Sb-125 Ci	Co-60 Ci
RCS	REACTOR COOLANT SYSTEM	67,286	3/7/86	3.06E+01	4.58E+02	6.62E+01	1.88E+00	9.17E+00	2.39E+00
PWST-1	PROCESSED WATER STORAGE	109,081	2/22/86	1.24E+02	6.61E-03	2.81E-03			
PWST-2	PROCESSED WATER STORAGE	480,134	2/24/86	5.09E+02	9.63E-02	8.00E-03			
CO-T-1A	CONDENSATE STORAGE	101,518	3/3/86	2.15E+01	6.92E-02	1.69E-03			
WDL-T-9A	EVAP. COND. TEST TANK	5,610	4/12/83	2.76E+00	5.48E-04	2.00E-04	2.00E-05		1.91E-05
WDL-T-9B	EVAP. COND. TEST TANK	2,231	4/17/83	1.10E+00	7.43E-04	4.72E-05	2.96E-06		
CC-T-1	EPICOR II OFF-SPEC	20,500	3/5/86	1.01E+01	4.50E-02	1.40E-02	3.80E-04	3.80E-03	
CC-T-2	EPICOR II CLEAN	16,887	11/15/85	5.62E+00	1.92E-02	9.59E-03		7.03E-03	4.15E-04
SFP-B	SPENT FUEL POOL "B"	241,690	3/2/86	4.12E+01	3.02E-02	3.29E-03			
SDS-T-1A	SDS MONITOR	373	3/7/86	1.07E-01	7.48E-03	1.38E-03		9.32E-04	
SDS-T-1B	SDS MONITOR	497	10/10/85	1.37E-01	1.82E-03	1.88E-03		1.77E-03	1.30E-04
WDL-T-1A	RC BLEED HOLDUP	3,810	2/24/86	1.23E+00	4.76E-01	1.34E-01	3.09E-04	6.63E-03	1.30E-03
WDL-T-1B	RC BLEED HOLDUP	4,420	3/7/86	2.17E+00	2.84E+01	3.35E+00	9.37E-02	5.69E-01	1.10E-01
WDL-T-1C	RC BLEED HOLDUP	87,116	10/31/85	3.68E+01	5.40E+02	3.68E+01		1.75E+01	1.41E+00
BWST	BORATED WATER STORAGE	450,915	3/4/86	1.15E+02	6.60E-01	2.26E-01	1.59E-02		4.69E-03
WDL-T-8A	NEUTRALIZER	8,675	2/28/86	2.96E+00	4.86E+00	6.24E+00	1.74E-01		
WDL-T-8B	NEUTRALIZER	8,605	3/1/86	2.21E+00	2.51E+00	5.88E+00	1.73E-01		
WDL-T-2	MISCELLANEOUS WASTE HOLDUP	3,712	2/28/86	9.69E-01	1.10E+00	2.39E+00	8.88E-02		
WDL-T-11A	CONTAMINATED DRAINS	1,931	3/1/86	1.53E-04	1.97E-04	3.07E-04	8.88E-06		
WDL-T-11B	CONTAMINATED DRAINS	820	3/1/86	4.35E-08		3.41E-08			
	CHEM CLEANING BLDG SUMP	1,600	3/2/86	2.86E-01	6.99E-03	5.60E-03		2.16E-02	8.02E-05
	AUXILIARY BLDG SUMP	8,917	10/4/85	2.91E+00	2.69E+00	8.18E-01			
	REACTOR BLDG BASEMENT	43,082	4/26/85	4.24E+00	2.61E+02	7.99E+02			
SFP-A	SPENT FUEL POOL "A"	205,234	3/27/86	2.02E+02	2.49E+01	6.84E+00	1.88E-01	2.02E+00	1.94E-01
	DEEP END OF TRANSFER CANAL	50,685	3/12/86	6.64E+01	5.70E+00	1.91E+00	4.09E-02	6.44E-01	5.55E-02
	TOTAL AS OF 1/1/86	1,908,417		1182.75	1331.17	929.49			

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[a] This table was taken directly from the GPU Report (GPU 1986)

Appendix B - Decontamination Factors Required to Ensure that the Dose from Radionuclides other than Tritium are Relatively Insignificant

The source term data shown in Appendix A were analyzed to determine the decontamination factor necessary to ensure that none of the five radionuclides listed in the inventory, would contribute more than 1% of the radiation dose to members of the public from tritium during the release of the waste water.

B.1 Evaluation of a Process Releasing All Radionuclides to the Atmosphere

For release to the atmosphere, it is assumed that no effluent would be released to water and that the radionuclides are released during processing over a period of one year. The calculation was made using the AIRDOS-EPA (Moore *et al*. 1979) computer code.

It was also assumed that the radionuclides would be released at a constant rate during the processing of the waste water. Assumptions of the type given in NCRP Report No. 76 (NCRP 1984) were used for atmospheric dispersion and environmental transport and for the potential pathways of significance. Dose estimates were made for each radionuclide and then normalized to that for tritium. All of the values are rounded to one significant digit. The results are given in Table B-1.

Table B-1 - The significance of doses from five radionuclides relative to tritium for releases to atmosphere

Radionuclide	Ratio of Doses to that from Tritium
^{3}H	1
^{60}Co	20,000
^{90}Sr	30,000
^{125}Sb	3,000
^{134}Cs	30,000
^{137}Cs	20,000

Although the uncertainty is probably less than a factor of ten, for the purpose of applying these data to the situation at TMI, an arbitrarily chosen criteria and doses from other radionuclides should not give rise to radiation doses greater than 1% of that from tritium.

The data in Table B-1 indicate that if the source term for ^{90}Sr is 30,000 times less than that for tritium, the dose from ^{90}Sr would be no more than that from tritium assuming the releases of each are occurring simultaneously and are to the atmosphere. Thus, if the source term for ^{90}Sr is 3,000,000 times less than that for tritium, the dose will be no more than 1% of that from tritium.

Since the source term for tritium is 4.86 GBq/m^3 (1.3 x10^{-1} µCi/cm^3), a ^{90}Sr concentration of 1.6 KBq/m^3 (4.3 x 10^{-8} µCi/cm^3 will result in a dose of 10% of that from tritium. Using 100% process values from Table 2-5 of the July 1986 GPU Report (GPU, 1986) we find a ^{90}Sr concentration of 0.37 MBq/m^3 (1 x 10^{-5} µCi/cm^3. This value, taken together with an evaporator decontamination factor of 1 for tritium and between 100 and 1000 for ^{90}Sr results in a release concentration that would be 4.8 GBq/m^3 (1.3 x 10^{-1} µCi/cm^3) for tritium and 3.7 KBq/m^3 (1 x 10^{-7} µCi/cm^3) to 0.37 KBq/m^3 (1 x 10^{-8} µCi/cm^3) for ^{90}Sr. If it is possible to attain a decontamination factor of between 1000 and 10,000 the 40% process value as taken from Table 2.1 would meet these criteria.

B.2 Evaluation of a Process Releasing All Radionuclides to Surface Water

For releases to surface water, it is assumed that tritium and other radionuclides are released to water and that no effluent enters the atmosphere directly during processing. Both drinking water and consumption of aquatic foods are included in the analysis. The results are given in Table B-2.

Table B-2 - The significance of doses from five radionuclides relative to tritium for releases to surface water

Radionuclide	Ratio of Doses to that from Tritium
^{3}H	1
^{60}Co	1,100
^{90}Sr	2,000
^{125}Sb	100
^{134}Cs	2,200
^{137}Cs	1,500

Again, for the purpose of applying these data to the situation at TMI, a factor of two orders of magnitude (100) has been used. If we again consider ^{90}Sr and include this factor of 100, then a source term for ^{90}Sr which is a factor of 200,000 less than the source term for tritium would give rise to a radiation dose of 1% of that from tritium.

Since the source term for tritium is 4.8 GBq/m^3 (1.3 x 10^{-1} µCi/cm^3), the ^{90}Sr concentration must be less than 24 KBq/m^3 (6.5 x 10^{-7} µCi/cm^3) for the dose to be lower by a factor of 100 from that due to tritium. Using the 100% process values from Table 2-5 of the July 1986 GPU Report (GPU, 1986) we find a ^{90}Sr concentration of .37 MBq/m^3 (1 x 10^{-5} µCi/cm^3). Processing of the waste through the evaporator would ensure that the effluent concentration of ^{90}Sr would be 200,000 times less than the tritium concentration.

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DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
Rockville MD 20857

FEB 26 1987

Dr. Michael T. Masnik
Acting Director
Three Mile Island-2 Cleanup
  Project Directorate
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Masnik:

The Center for Devices and Radiological Health staff has reviewed the Draft Supplement 2 to the Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive waste resulting from the March 28, 1979, accident at the Three Mile Island nuclear station Unit 2 (NUREG 0683, Supplement No. 2, dated December 1986). Our efforts were directed to an evaluation of the public health and safety impacts associated with the proposed alternatives for disposal of water which was contaminated as a result of the accident. We have the following comments to offer:

1. The discussion in Chapter 3 has adequately assessed the alternatives for disposition of the accident-generated water together with the principal environmental impacts for each alternative. It appears that these impacts would involve minimum offsite individual and population dose and occupational dose from releases of tritium, cesium-137 and strontium-90 as a function of the alternative selected.

2. The environmental pathways identified for each alternative covers the possible emission pathways that could impact on the population in the environs of TMI and at potential waste disposal sites. The radiation dose calculation methods and assumptions presented in Appendix B have provided reasonable estimates of the doses to the maximally exposed individual and the population within the 50-mile (80 kilometer) radius of the site. The range of impacts from the alternatives considered are shown in Table 6.1 and indicate that the doses are minimal and well within current radiation protection standards.

3. The discussion in Section 5.2 has adequately assessed the radiological impacts and health effects to the workforce population, the maximally exposed individual, and the offsite population within 50 miles (80 kilometers) from exposure to radioactive effluents. We unequivocally concur with the statement in Section 5.2, page 5.5, paragraph 2, that states "These risks are very small in comparison to cancer incidence from causes unrelated to the disposal of the accident-generated water."

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4. Some of the alternatives for disposal of accident-generated waste involve offsite truck shipments. Consequently, it is possible to estimate the number of non-radiological fatalities and injuries that are likely to occur. We agree absolutely with the conclusion in Chapter 6 that the most significant potential impact associated with any disposal alternative is the risk of physical injury as a result of a transportation accident.

Thank you for the opportunity to review and comment on this Programmatic Environmental Impact Statement.

Sincerely yours,

John C. Villforth

John C. Villforth
Director
Center for Devices and
Radiological Health

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44 Carriage Lane
Annapolis, Md.21401
February 22, 1987

The Honorable Arthur E. Morris
Mayor of Lancaster
P.O. Box 1559
120 N. Duke Street
Lancaster, Pa. 17108

Dear Art,

I regret to have to miss the upcoming meeting of the TMI Advisory Panel. I will be on business travel to the west coast Mon. through Friday.

In reading the transcript of the Jan. 21,1987 meeting I noted that the alternative of ocean disposal of the cleaned-up accident residual water was not completely considered. (See page 22) The reason cited was an international moratorium on the ocean disposal of any radioactive material. It struck me odd and perhaps a source of confusion for the public that on one hand Federal authorities do not consider release of the water to the Susquehanna a significant health risk yet the U.S. is reportedly a party to a moratorium that would exclude ocean disposal. What goes??

I made a few phone calls and did a little library research. I learned enough to convince me that this alternative should be examined more thoroughly than it seems to have been. Let me share with you and the panel a brief summary of the current ocean disposal situation as I understand it.

The United States is a signatory to the international "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter". This Convention is also referred to at times as the London Dumping Convention. This Convention was developed in 1972 and was ratified by the U.S. in 1975. Under the terms of this Convention , ocean dumping of a group of materials considered particularly hazardous is prohibited. Included in this group(Annex I) are"high level radio-active wastes or other high-level radio-active matter". The use of the ocean for disposal of low-level radio active wastes is not prohibited by the convention but such dumping "requires a a prior general permit".

The U.S. did permit a limited amount of ocean disposal of low-level radioactive waste in drums years ago but this practice was stopped,largely because of both national and international sensitivities about use of the oceans for such purposes. With the availability of alternate means, such as shallow land disposal, there has been no need for generators

A.25

of low-level wastes in the U.S to press for ocean disposal. Other countries less endowed with land they are willing to dedicate to such use have been studying the technical and environmental implications of ocean disposal of ~~[illegible]~~
~~[illegible]~~
~~[illegible]~~

I~~[illegible]~~ have shown no technical reasons for precluding this method of disposal, there remains considerable uneasiness on the part of some countries to endorse the practice. In 1983, delegates to the London Dumping Convention voted to suspend low-level dumping waste exercises pending completion of an experts' study. The study proved inconclusive. In September 1985,at a similiar session,the London Convention passed a resolution for the continued banning of ocean dumping of low-level radioactive waste. This was a non-binding resolution. The United States joined with the U.K.. Canada, France, South Africa,and Switzerland in voting against the resolution. The United States delegate nonetheless did state that the U.S. had no plans for ocean disposal.

An official at the EPA advised that the Agency currently has no rules in place that spell out the criteria that would apply for getting a general permit as prescribed by the Convention. However,it is possible such guidance may be forth coming next year.

It may well be that the ocean disposal alternative may not be viable given the time frame for making decision about the TMI water. Nonetheless, it seems to offer enough positive possibilities that it should not be dismissed without closer scrutiny.

Respectfully,

Joseph J. DiNunno

P.O. Box 983
Pierre, South Dakota 57501
February 21, 1987

Dr. Michael T. Masnik
TMI Project Directorate
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Comments on Draft Supplement #2, NUREG-0683, Programmatic Environmental Impact Statement related to Decontamination and Disposal of Radioactive Wastes resulting from March 28, 1979 Accident, Three Mile Island Nuclear Station, Unit 2, Docket #50-320 (December 1986)

Dear Dr. Masnik:

I have reviewed this draft supplement and wish to make the following comments.

In the Summary on page v, I note that the disposal volume of accident-generated water was "expected to be 40,000 to 80,000 cubic feet (11,000 to 13,000 cubic meters)". I believe that cubic feet have been converted here into square meters and not cubic meters.

In the second paragraph of the Summary, I see that the final processing will involve about 2.1 million gallons, or 7.9 million liters with about 1,000 curies of tritium and smaller amounts of cesium 137 and strontium 90. There is no mention here of uranium, plutonium or other transuranics,nor of other of the 500 different radionuclides of potential importance in the assessment of contamination around nuclear facilities. This is a very serious oversight. I believe that the concentration of all of these should be determined.

The Summary estimates that the considered disposal alternatives will have an impact of only 0 to .003 radiation-induced cancer deaths in the worker population and only 0 to 0.0003 for radiation-induced cancer fatalities in the offsite population. If this water is really that innocuous, should the plant save it to be used in drinking water fountains for the employees at the plant? Or should it be carbonated, bottled, and sold in stores as spring water?

C002

As I recall, the reactor core in this plant was partially melted down and this water has been in and around the 100 tons of partially melted uranium (with plutonium and other activation and fission products) for nearly seven years. Many of these metals and compounds are quite water-soluble, especially uranium. The Schwarzwalder Uranium Mine, for example, near Golden, Colorado, at times pumps out more than a million gallons of water each day, and in the past (perhaps today also) this has been discharged into public water supplies. The water at times contains more than 10,000 picocuries per liter of alpha radiation from the uranium. The contact there between water and uranium ore has been at rather cool temperatures, not in a super-heated environment such as has occurred at TMI-2. I can't believe that there is not a large amount of uranium and its progeny and other transuranics dissolved in this water in TMI-2. And yet, in reading this report I didn't see any mention of alpha radiation levels per liter of water nor of the concentration of uranium and other transuranics in the water.

In the manuscript there was a discussion of background radiation levels in surface waters downstream and these discuss the levels of alpha radiation and radium in the water amounting to several picocuries per liter. The lack of information in this draft report on the concentration of uranium and transuranics in the waste water is very puzzling.

The range and concentrations of radionuclides in the water should be determined by number of agencies and independent laboratories, and the radiation protection guides should be those developed by the EPA or by more conservative independent researchers. For example, the EPA has advised a limit of 10 picocuries per liter of uranium in water, in contrast to a limit of 6000 supported by the Dept. of Energy. Further, the units in the book should be consistent with present EPA practice. After all, this is an environmental impact statement. Radiation activities should be expressed in terms of picocuries per liter of water and picocuries per cubic meter of air. The use of awkward units like microcuries per milliliter and the use of large negative exponents should be avoided,since these are confusing even to experts and especially confusing to the public.

In several places the text reads as if the tritium in the water is there as the gas. In fact, tritium (which is hydrogen) oxidizes with oxygen and ozone over time to form tritiated water or heavy water. The evaporation process will simply evaporate off all the tritium as tritiated vapor which is much more toxic on inhalation or ingestion than is tritium gas.

I think that we do not have enough information to make a decision about the disposition of this water. I recommend against any of the methods of disposal at this time, until there has been exhaustive analyses of the water by a number of agencies and independent laboratories at universities, including one or two in Canada. The water should be analyzed also, for example, by the EPA and by the U.S. Geological Survey, which does get involved in what happens to water in the environment. I have attached a figure from an EPA report on liquid emissions from a nuclear power plant in normal operation to show the range of radionuclides released in such normal operations.

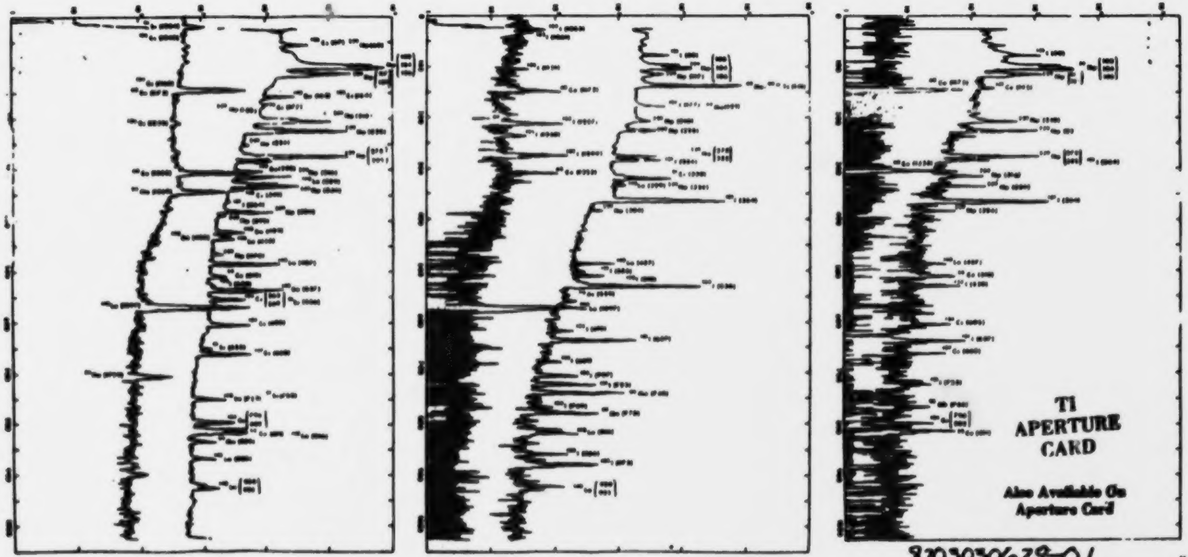
I think we need to know more about the assumptions made in calculating doses to persons around the plant from the radionuclides which might be released by the various alternatives proposed. Those dose estimates should also include exposure to every one of the 500 radionuclides of potential importance in this water, and should also consider concentrations of radionuclides by marine plants and animals in the food chain.

Sincerely,

Carl J. Johnson

Carl J. Johnson, M.D., M.P.H.

Figure 24



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4410-87-L-0032
Document ID 0165P

March 17, 1987

Michael T. Masnik
Three Mile Island Cleanup Project Directorate
Office of Nuclear Reactor Regulations
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Masnik:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Comments of Draft Supplement 2 to the
Programmatic Environmental Impact Statement - Three Mile Island Unit 2

The purpose of this letter is to provide GPU Nuclear comment on Draft Supplement 2 to the Programmatic Environmental Impact Statement - Three Mile Island Unit 2 (PEIS). In addition to the detailed comments provided herein, the information provided in GPU Nuclear letters 4410-86-L-0018 dated February 3, 1987, and 4410-87-L-0023 dated February 18, 1987, should be considered as an integral part of our comments on Supplement 2.

Sincerely,

/s/ F. R. Standerfer

F. R. Standerfer
Director, TMI-2

FRS/JJB/eml

Attachments

cc: Director - TMI-2 Cleanup Project Directorate, Dr. W. D. Travers

ATTACHMENT 1
4410-87-L-0032

COMMENTS TO THE DRAFT SUPPLEMENT 2 TO THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT - THREE MILE ISLAND UNIT 2

1. Summary, page VI - Radiation-induced cancer fatalities in the off-site population is different from that listed in pages 5.5, 6.1 and 6.2 of the report.

2. Nomenclature, page XXVI - Tritium contains three nucleons vice neutrons.

3. Section 2.2, pages 2.3 and 2.4 - The discussion about drinking the processed water should be deleted. The doses given in Table 2.3 for drinking the processed water may be confusing to the public.

4. Sections 2.2.1, 2.2.2 and 2.2.3, pages 2.5, 2.6, 2.7 and 2.9 - These sections include good discussions about the characteristics, interactions, and environmental concentrations of the radionuclides to be released. If additional radionuclides are added to the inventory list, as a result of the information provided in GPU Nuclear letters 4410-87-L-0018 and 4410-87-L-0023, the PEIS should be amended to include similar discussions about the additional radionuclides.

5. Section 2.2.3.2, page 2.9 - The typical dietary intake of strontium should include a time period, e.g., 1.9 milligrams/day vice 1.9 milligrams.

6. Section 2.2.3.3, page 2.9, first paragraph - Background levels of Sr-90 are "routinely" measured, rather then "rarely" measured.

7. Section 2.2.5.3, page 2.12, second paragraph - "Very low concentrations are also detrimental." should be, "Excessively low concentrations are also detrimental."

8. Section 3.1.1, page 3.3 - Should note that evaporator bottoms may be in the form of a dry powder, in which case solidification will not be required; dry powder disposal may be in drums.

9. Section 3.1.1.1, page 3.3 - Should indicate that the evaporator is modular vice transportable, i.e., the evaporator may not be transportable as a single unit. It may require several modules to be transported to the site for assembly.

10. Section 3.1.1.1, page 3.3, first paragraph - Should change the sixth sentence of this section to read, "Some form of moisture separator or vapor superheater would be provided to assure that liquid droplets and dissolved components are not discharged with the water vapor."

11. Section 3.1.1.1, page 3.3; Section 3.1.1.2, page 3.6 - Although the original GPU Nuclear proposal anticipated that exhaust from the evaporator would be routed to an existing atmospheric discharge point, this plan has been modified. It is anticipated that a separate exhaust stack (currently anticipated to be 100 feet high) will be installed with the evaporator.

12. Section 3.1.1.1, page 3.3 - Although the original GPU Nuclear proposal assumed a 3 gal/min flowrate for the evaporator, it should be noted that higher flow rates are acceptable if evaporator effluents comply with Technical Specifications Limits.

13. Section 3.1.1.1, page 3.6; Section 4.5, page 4.12 - Should indicate that the low level waste (LLW) may be shipped to any commercial LLW burial site and that the U.S. Ecology site near Richland, Washington, was specifically evaluated as it was judged to be the bounding case from a transportation accident standpoint.

14. Section 3.1.1.2, page 3.7, third paragraph - The annual dose values stated (e.g., "dose to the maximally exposed individual is estimated to be 0.9 mrem to the bone and 0.2 mrem to the total body") do not appear to be correct. This annual dose appears to result in a 50-year dose commitment higher than 3 mrem to the bone and 0.5 mrem to the total body.

15. Section 3.1.2.2, page 3.12, third paragraph - The person-rem to the bone (2 person-rem) is less than the person-rem to the total body (3 person-rem). However, the bone dose to the maximally exposed individual is higher than the total body dose. There appears to be an error in the person-rem numbers.

16. Section 3.2.1.2, page 3.16, first paragraph - Should include an assessment due to airborne dispersal of solids.

17. Section 3.2.1.3, pages 3.16 and 3.17 - Should also include a dose from the groundwater pathway.

18. Section 3.5.1, page 3.31 - EPA drinking water standards for Sr-90 and Cs-137 are not mentioned.

19. Figure 4.4, page 4.5 - Population distribution is not the same as used by TMI. The population distribution used by TMI is provided in Attachment 2.

20. Section 4.1.3, page 4.9 - Normal groundwater elevation is closer to 282' MSL average.

21. Section 4.2.2., page 4.11 - Other endangered species occur in the TMI vicinity. For example, ospreys have been observed around the York Haven impound pond by TMI personnel. Paragraph should indicate that other endangered species may visit the site.

22. Section 5.2, page 5.4 - References to BEIR I and BEIR III are confusing. The section should clarify the intended use of each report.

23. Appendix B, page B.1 and Section 3.1.1.3, page 3.9 - Chester County and Baltimore City have water intakes in the Susquehanna River. Although they generally do not use Susquehanna River water, that potential exists. Therefore, TMI uses 6 million persons for the total population, including these large metropolitan areas. Since the possibility exists that these two water sources could be in use for short periods of time, accident calculations should include these populations.

24. Section 3.4.2.2, page 3.29 - What river discharge flowrate is used? Since river flowrate is an important factor in population dose, a short term release could be deliberately conducted during high river flow to reduce population dose. The option should discuss the potential reduction in population dose commitment with proper timing of the release (i.e., at spring flood).

25. Appendix B, page B.1 and Section 5.1, page 5.1 - Doses to the population should include the entire fed population in the 50 mile radius. Lancaster County has one of the highest foodstuff value productions by county in the entire country. Therefore, export of these foodstuffs should be considered. It is inconsistent to incorporate the questionable bay shellfish pathway and not the fed population within 50 miles. While the resident population is about 2.2 million people, the fed population can approach 15 million people.

26. Appendix B, page B.1 and Section 5.1, page 5.1 - TMI used 6 million persons as the drinking water population. Some discussion of the size of the potentially exposed population in Chester County and Baltimore City would be appropriate.

27. Appendix B, page B.1 - The river flowrate given here should be included in the discussions in the body of the report.

28. Appendix B, page B.1 - A near field dilution factor of 0.2 is appropriate for the fish pathway, based on Regulatory Guide 1.109 and TMI/Sutron dye studies of the Susquehanna River. Why has a flow of 3150 cfs been used for the fish pathway only?

29. Appendix B, page B.2 - Inclusion of the Bay shellfish pathway is inappropriate. There is clearly a dramatic dilution in the bay. The behavior of Susquehanna River water in the bay is not modeled. Surely channel flow of the lighter freshwater, dilution in the bay, flushing by tidal action, and input from other rivers (Chester, Patapsco, Potomac, Choptank) make the calculation grossly inaccurate. Further, many shellfish grounds are in tributary waters which may not be impacted by Susquehanna River water. Finally, long hold up times in the impounds of the numerous dams downstream contribute to natural removal processes.

30. Appendix B, page B.3 - Input ingestion parameters for the concerned population do not appear to be consistent with Regulatory Guide 1.109.

31. Appendix B, page B.3 - Annual 50-mile radius production figures are not consistent with those used at TMI; i.e., approximately 2×10^8 kg/yr meat, 2×10^9 kg/yr vegetables and 2×10^7 l/yr milk.

32. Appendix B, page B.3 - The pathway fractions are inconsistent with those used at TMI. Based on the annual land use census, most milk and beef animals are on pasture for about 7 months of the year.

33. General - The total amount of processed water at TMI-2 is increasing at a faster rate than originally predicted. This increase is due to the use of demineralized water for various plant processes that were not originally anticipated (e.g., demineralized water has been borated to requried RCS concentration for use in the coagulant addition system). GPU Nuclear now anticipates that approximately 2,300,000 gallons of water will require evaporation. However, since this additional water was uncontaminated prior to use at TMI-2, the amount of radionuclides available for release from TMI-2 remains constant.

```
      POPULATION AFFECTED BY GASEOUS PATHWAY PEOPLE

  DIRECTION  S     (DOWN WIND)
   3.000E+01   3.600E+01   4.340E+02   6.680E+02   4.640E+02
   8.307E+03   7.401E+04   2.836E+04   8.542E+04   1.034E+05
  DIRECTION  SSW   (DOWN WIND)
   1.500E+01   4.100E+01   3.040E+02   4.160E+02   3.870E+02
   3.975E+03   1.910E+04   4.263E+04   2.490E+04   4.179E+04
  DIRECTION  SW    (DOWN WIND)
   1.500E+01   1.130E+02   3.200E+02   4.400E+02   5.160E+02
   3.416E+03   1.219E+04   1.320E+04   2.249E+04   2.250E+04
  DIRECTION  WSW   (DOWN WIND)
   1.400E+01   2.370E+02   3.200E+02   4.400E+02   5.760E+02
   3.467E+03   1.284E+04   1.301E+04   1.877E+04   2.180E+04
  DIRECTION  W     (DOWN WIND)
   1.800E+01   3.330E+02   3.200E+02   4.400E+02   5.020E+02
   5.453E+03   1.362E+04   4.265E+04   3.250E+04   3.789E+04
  DIRECTION  WNW   (DOWN WIND)
   1.500E+01   2.510E+02   3.060E+02   4.640E+02   5.990E+02
   8.121E+03   3.209E+04   1.464E+04   1.166E+04   8.473E+03
  DIRECTION  NW    (DOWN WIND)
   1.300E+01   1.210E+02   1.690E+02   2.590E+02   1.014E+03
   2.986E+04   6.215E+04   8.230E+03   1.010E+04   1.066E+04
  DIRECTION  NNW   (DOWN WIND)
   9.000E+00   5.700E+01   1.275E+03   8.290E+02   1.093E+03
   1.662E+04   1.281E+04   1.803E+04   1.597E+04   1.750E+04
  DIRECTION  N     (DOWN WIND)
   7.000E+00   8.100E+01   3.104E+03   5.654E+03   1.779E+03
   1.326E+04   1.274E+04   2.319E+04   4.190E+04   3.855E+04
  DIRECTION  NNE   (DOWN WIND)
   3.000E+01   1.330E+02   2.720E+02   3.240E+02   3.900E+02
   9.264E+03   1.484E+04   2.457E+04   1.972E+04   4.388E+04
  DIRECTION  NE    (DOWN WIND)
   2.000E+01   1.330E+02   2.210E+02   3.100E+02   3.900E+02
   4.282E+03   2.229E+04   2.553E+04   1.967E+04   7.477E+04
  DIRECTION  ENE   (DOWN WIND)
   3.700E+01   1.330E+02   2.210E+02   3.100E+02   3.880E+02
   2.326E+03   1.630E+04   2.776E+04   3.575E+04   1.585E+05
  DIRECTION  E     (DOWN WIND)
   4.000E+01   1.170E+02   2.210E+02   4.250E+02   5.010E+02
   1.068E+04   3.074E+04   3.684E+04   3.432E+04   4.745E+04
  DIRECTION  ESE   (DOWN WIND)
   3.700E+01   1.040E+02   1.600E+02   2.900E+02   4.960E+02
   3.693E+03   3.787E+04   9.597E+04   4.031E+04   5.821E+04
  DIRECTION  SE    (DOWN WIND)
   3.400E+01   1.030E+02   1.600E+02   2.200E+02   2.790E+02
   2.444E+03   2.158E+04   2.215E+04   3.273E+04   3.435E+04
  DIRECTION  SSE   (DOWN WIND)
   2.500E+01   8.600E+01   1.650E+02   3.110E+02   2.280E+02
   3.678E+03   1.862E+04   2.228E+04   2.986E+04   5.910E+04

  DISTANCES (METERS) FOR ABOVE TABLE
   6.100E+02   2.413E+03   4.022E+03   5.631E+03   7.240E+03
   1.207E+04   2.414E+04   4.023E+04   5.632E+04   7.241E+04
```

Department of Energy
Washington, DC 20585
March 31, 1987

Mr. William D. Travers
Director
TMI-2 Cleanup Project Directorate
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
P.O. Box 311
Middletown, Pennsylvania 17057

Dear Mr. Travers:

This is in response to your letter of December 29, 1986, that forwarded Draft Supplement 2 to the Three Mile Island Unit 2 (TMI-2) Programmatic Environmental Impact Statement for the Department of Energy's review and comments. The Draft Supplement addresses potential environmental impacts associated with the disposal of radioactively contaminated water resulting from the TMI accident that currently is stored at the TMI site.

The Draft Supplement includes the evaluation of 10 alternatives, summarized in Table 3.1, with respect to: (1) systems and operations required for implementation; (2) estimated environmental impact, including risk of radiation exposure to the public and to workers; (3) probability and consequences of accidents; (4) commitment of resources, including cost; and (5) regulatory constraints.

Based on this evaluation, the Nuclear Regulatory Commission (NRC) staff concludes that the accident-generated water can be disposed of without significant environmental impact, and that among the alternatives evaluated, no alternative is clearly preferable. Estimated radiological risks to the general public are very small fractions of estimated normal incidence of cancer fatalities and genetic disorders. The most significant potential impact is the risk of physical injury in the event of transportation accidents for those alternates involving offsite disposal. One of the alternatives, involving indefinite continuation of liquid storage at the TMI site, is considered inappropriate because it simply defers the ultimate decision on disposal. The GPU Nuclear Corporation (GPUNC) already has proposed to the NRC the alternative involving evaporation and solidification of bottoms at the TMI site and disposal at a commercial disposal site.

Three of the alternatives evaluated involve disposal of the TMI contaminated water at a DOE facility, either Hanford or the Nevada Test Site (NTS). Of these alternatives evaporation from a specially lined pond at the NTS may be a feasible alternative;

however, neither disposal by deep well injection at NTS nor crib disposal at the Hanford site should be considered as reasonable alternatives.

DOE policy, embodied in Order 5820.2, issued February 6, 1984, states that disposal operations involving discharges of liquid low-level waste (LLW) directly to the environment or on natural soil columns shall be replaced by other techniques, such as solidification prior to disposal or in-place immobilization, unless specifically approved on a case-by-case basis. In addition, the Office of Environment, Safety and Health is committed to encouraging and supporting activities related to discontinuing the practice of discharging contaminated liquids to the ground. Further, if liquid LLW were disposed to units such as cribs or injection wells such units would be potential sites under the Comprehensive Environmental Response, Compensation, and Liability Act, which may require characterization studies to determine the need for remedial actions to prevent or minimize the release of hazardous substances, including radionuclides, to the environment. Consequently, the alternatives involving direct discharge to the soil through cribs at Hanford or injection wells, at NTS should be eliminated from further consideration.

As stated in the EIS, the alternatives involving offsite shipment of the water or the "solidified water" (without prior evaporation) would result in an estimated number of traffic accidents much higher than the other alternatives because of the greater quantity of shipments. Moreover, the solidification-offsite shipment alternative results in a total waste volume an order of magnitude or more higher than that for the other alternatives. For these reasons, we believe the environmentally preferred alternative appears to be onsite evaporation.

Please find enclosed a list of technical comments to assist you in revising the draft EIS.

Yours truly,

Mary L. Walker
Assistant Secretary
Environment, Safety and Health

Enclosure

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ENCLOSURE

DOE Technical Comments for TMI-2 EIS Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979 Accident

1. There appear to be errors on Table 2.5 in the tritium concentration values. The correct value for both soluble and insoluble forms of tritium as taken from the NRC regulation 10 CFR Part 20 is 3×10^{-3} mCi/ml.

2. Quantification of air dispersion and water dilution would further the arguments on minimal environmental impacts associated with the evaporation and river discharge options. In the case of river discharge a calculation of the concentration of the pertinent isotopes at the point(s) of water supply intake and at the tap would be most useful. All assumptions used in these calculations should be provided in the EIS.

3. Appropriate DOT regulations for transport of radioactive material should be referenced and discussed in relation to the alternatives involving transportation.

4. Similarly, the document should explain the status of agreements/consultation with DOE concerning use of DOE facilities for waste disposal, to help the reader understand the extent to which these are realistic alternatives.

5. Doses and risks for an accident involving contaminated water should be quantified. Table 5.1 includes no offsite dose for options 3.2.1 - 3.2.3. However, a single truck accident could lead to potential exposures higher than any others in the table.

6. The format for discussing the treatment options, system and operation, estimated environmental impacts, potential accidents, and regulatory constraints is excellent. Very little was said about required environmental monitoring for each option e.g., water table wells, establishment of background conditions at selected disposal sites, and stream and river sampling.

7. The summary should include Table 5.1. This is the alternative impact summary of the report and is the information a decision will be based upon.

8. The "achievable" column in Table 2.2 could be accompanied by more explanation from the text.

C

THE ADVISORY PANEL FOR THE DECONTAMINATION OF
THREE MILE ISLAND UNIT 2

March 31, 1987

Vice Admiral Lando W. Zech, Jr.
Chairman
Nuclear Regulatory Commission
Matomic Building
1717 'H' Street, N.W.
Washington, D. C. 20555

Dear Chairman Zech:

A meeting of the NRC's Citizen Advisory Committee for the Decontamination of Three Mile Island Unit II was held on Wednesday, March 25, 1987. The purpose of the meeting was to receive public testimony and comment on the Draft Supplement to the Environmental Impact Statement dealing with the disposal of accident-generated water and the disposal option of on-site evaporation recommended by GPU. This meeting, which was a continuation of a 5-hour session held in Lancaster, Pennsylvania on February 26, began at 6:00 p.m. and concluded shortly after 11:00 p.m.

At both of these meetings virtually all public comment was in opposition to the proposed evaporation plan put forth by the operator. Continued storage in the holding tanks on the island was the preferred option put forth by most citizens. The public, in stressing this option, expressed distrust of GPU's operation of the plant in general and the evaporation in particular, together with the strong feeling that the area around the plant had already received radiation exposure from the accident and subsequent cleanup and did not want to add any additional exposure, at any level.

GPU testified that any one of a number of alternatives reviewed would safely do the job and that on-site evaporation was their recommended alternative. They stressed that they were very sensitive to community concerns and that is why the discharge to the Susquehanna River was not given strong consideration.

The NRC staff outlined the work that they had performed in completing the Draft Supplement EIS. The staff stressed that no alternative was found to be clearly preferable and that the total quantified impact of any alternative is very small. According to the staff, the most significant potential impact associated with any disposal alternative is the risk of physical injury associated with transportation accidents. Lastly, NRC staff stated that indefinite on-site storage is inconsistent with the Commission's policy that the cleanup, including the removal of radioactive wastes from the TMI site, be carried out safely and expeditiously.

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Following the receipt of these comments, the Panel then attempted to develop a consensus on the issues for recommendation to the Commission. The following motions were considered by the Panel:

1) A motion that "the Draft Supplement to the Environmental Impact dealing with the disposal of the accident-generated water is an acceptable document" passed with a vote of eight (8) for and two (2) against.

2) A motion to "oppose the evaporation option" put forth by GPU was passed with a vote of five (5) for, four (4) against and one (1) abstention.

3) A motion to "maintain the status quo until a stronger case can be made for definitive action, including evaporation or a more desirable alternative" was not approved due to a vote of five (5) for and five (5) against.

The Panel devoted a considerable amount of time to the water disposal matter. I have attempted to summarize what happened at our meetings of February 26 and March 25. In order for the Commission members to get the total picture, the Panel would encourage you to review the entire transcripts of these meetings.

We look forward to meeting with you at 11:00 a.m. on April 16 in Washington; this will provide us with a further opportunity to discuss this subject, which is of considerable importance to the clean-up effort. Unfortunately, due to a long-standing commitment, I will be unable to join you in Washington. However, it is expected that the Panel will be well represented by ten (10) of our members; Joel Roth will act as the chair.

Please feel free to contact me should you have any questions in regard to this letter.

Sincerely,

Arthur E. Morris

Arthur E. Morris, Mayor.
Chairman

AEM/dk

cc: Mike Masnik
All Panel Members

TMIA: THREE MILE ISLAND ALERT, INC.
315 Peffer St., Harrisburg, Penna. 17102 (717) 233-7897

QUESTIONS CONCERNING THE NRC's REVISED EIS ON THE DISPOSAL OF RADIOACTIVE WATER

Q1:p.2.6 (p.3.1 & p.5.6 second paragraph).Second paragraph. "There is no evidence for a significant concentrartion process for tritium in either plants and animals". (NCRP '79). "No apparent enrichment or concentration effect for tritium has been found in aquatic or terrestial food chains." (NCRP '79). Does no concentration mean no adverse health effects? Are there are any studies that contradict these findings? Was this study the sole basis of your reporrt concerning tritium and its interaction with biological systems? If so, why?

Q2: p.2.11 What levels of boric acid or boron in the water would cause you concern? Also refer to last paragraph p3.28.

Q3: p.2.13 When was the EPA's NIPDWS drafted? Was it ever revised? Same ? for RCRA.

Q4: p.2.15 Since Pennsylvania is a non-Agreement state, and is bound by the NRC's decision, what recourse is left to the state or citizens who are dissatisfied with the NRC's decision? Can a decision be binding even if it violates other Pennsylvania environmental laws ? What if Pennsylvania becomes an Agreement state before the water issue is reolved? What bearing will that have on the process?

Q5: P.3.1.1.1 Why not let the transportable evaporator operate in closed cycle? How accurate has the volume reduction figure been in 3.1.1.2 at other plants? What if it is skewed a few magnitudes?

Q6: p.3.7 Do the maximum dose rates assume that all plant, aquatic and human life are chemically and radicactively pure before their exposed to the radioactive emissions from the water?

Q7: Do any of your cost breakdowns take into account inflation, regulatory/legal delays (3.1.1.4) logistical delays, etc. How much of a factor is economics when you analyze the alternatives?

Q8: p.3.1.2 & p3.10 Second paragraph. Would the NRC allow GPU to place concreted waste in a trench on site? Sixth paragraph. When is the NRC going to consider long-range monitoring at TMI?

Q9: p.3.10 What is a Hypalon cap? Is it any relation to the disasterous clay cap used at chemical sites in California?

Q10: p.3.12 Would DER allow unrestricted use of site after 30 years? p.3.13 You would have no problem w/ building or farming on this site after 30 years? Who will monitor the site?

Q11: p.3.15 Last paragraph. How do you assure that no civilians are upwind?

Q12: p3.22 First paragraph. How do you monitor the 50% tritiated water, and keep it separate from the 50% that is not monitored? Does this mean that the other 50% will not be monitored?

Q13: Why has the NRC adopted the De Minimis Waste Impacts Analysis Methodology? Are there methodologies that contradict or call into question the De Minimis methodology?

Q14: p.3.24 What if no LLW burials ite wants the waste? What if GPU doesn't want to use their alloted space at a site for the disposal of this waste?

Q15: p3.4.1 Will the release be publicized before disposal? 3.4.1.2 How are you so sure all exposures will be diluted? What guarantees exist to prevent GPU from adding more highly radioactive water before disposal? What will the NRC monitor? And how?

Q16: p. 3.4.2.3 Accident analysis. Why is a discharge of a batch of accident-generated water before treatment unlikely?

Q17: p3.31 What is meant by "ultimate disposal"? p.3.5.1.2 No other expected pathways of exposure to public?

Q18: p3.5.1.4 Why are no other impediments expected before license termination?

Q19: p.5.3 The environmental, health, economic and human costs associated w/the no action alternative is minimal. Why not endorse it?

Q20: p.5.4 Third paragraph. What is meant by "...biological mechanisms that can repair damage caused by cancer at low-levels".

Q21: Is there an endpoint to this process? Does the process end precisely at 2.1 million gallons of water? If so, what happens to additional water?

Q22: Why was there no meteorological study conducted?

TMIA: THREE MILE ISLAND ALERT, INC.
315 Peffer St., Harrisburg, Penna. 17102 (717) 233-7897

TMIA's COMMENTS TO THE NRC ADVISORY PANEL ON THE NRC's REVISED EIS ON THE DISPOSAL OF RADIOACTIVE WATER

In that this is a very sensitive subject I think the Panel should not rigidly enforce time constriants on questions and presentations by the community. In addition, I hope the water disposal issue does not become a secondary item after this meeting.

I appreciate the fact that GPU responded to my questions concerning Post Defueling Monitored Storage. However, I'm not satisfied with a number of the responses, especially the ones dealing with decommissioning. Rather than pursue a line of questioning tonight, I'll defer until the next meeting.

I am submitting a list of questions to the NRC concerning their revised EIS. I request that they be made a part of the official record. I'm speaking tonight on behalf of Three Mile Island Alert, which is a non-profit, safe energy group based in Harrisburg.

Both the NRC and GPU have stated that the quantities of radiation released during the disposal of the contaminated water would be "insignificant." They always says this! We don't believe that any radiation dose is safe, especially in this area where radiation has been vented steadily for the last 14 years. I don't remember a time when the utility admitted that "significant" levels of radiation have been released, including the 43,000 curies of Krypton-85 vented on Central Pennsylvania for 13 days in July 1980.

We have serious reservations about the disposal options sanctioned by the NRC. In fact disposal is an incorrect term. There will be no actual disposal, and no guarantee of containment. Instead, radioactive materials and industrial chemicals will be dispersed in the environment. We do however, have certain objectives we would like to see met.

- Our prime and overriding concern is minimizing radiation exposure to the local population and the environment. For example, we would like to see 100% of the water filtered and processed within a closed cycle.

- Worker exposure should be minimized, since many of them have human sponges for the last 7 and 1/2 years.

- Dose rates to populations outside of central Pennsylvania should also be minimized.

- Cost and time should not be factors. GPU should spend as much money and take as much time as needed to find the safest method of disposal.

Considering these objectives, alternatives such as dumping the water into the Susquehana River and on-site evaporation are clearly unacceptable, due to the potential harmful physical and psychological threat they present to our community.

We request the following steps be taken before a final decision is made: a meteorological study of the area surrounding TMI; a study examining the psychological stress that would result from the planned disposal methods; an inventory of all the radioactive elements and chemicals that are in the water; and a review of the GPU's current proposal and the NRC's revised EIS by an independent agency not affiliated with the nuclear industry or the government.

At this time I'd like to remind the panel of some of the past behavior of this utility and the NRC, because this is a crucial factor in understanding the built in distrust and fear of area residents.

We remember that in July of 1980, 43,000 curies of radioactive krypton-85 and other radioactive gasses were vented from Unit-2, even though TMI-2 was designed to release approximately 770 curies of krypton-85 a year. The venting occurred a little over a year after the the accident admidst widespread fear and concern. Later, in November the U.S Court Of Appeals for the District of Columbia ruled in Sholly vs. the NRC that the krypton venting was illegal.

We remember that in the spring of 1983, three senior level engineers charged that GPU and Bechtel deliberately circumvented safety procedures and harassed them for reporting safety violations. The NRC fined GPU and Bechtel $64,000 for intimidating and harassing Larry Parks.

We remember the reactor head lift between July 24 - 27, 1983, which was delayed due to brake failure on the polar crane. GPU vented radioactive gases into the environment, despite pledges by the NRC and GPU that no venting would take place during the head lift operation. GPU was later fined $40,000 by the NRC for the brake problem.

We remember that on June 1, 1984, the NRC released transcripts of closed NRC Commission meetings. The transcripts revealed a commitment on the part of a Commission majority to restart TMI-1 as soon legally and poltically possible. Also evident was significant disdain for public views on the restart issue, and a serious lack of understanding of the legal and technical issues. This is the same agency who will ultimately decide how the water will be disposed.

We rememember that between February 10-12, 1985 the Philadelphia Inquirer reported records at TMI demonstrated that in hundreds of cases, workers had been contaminated by radioactive materials either on the skin or through ingestion. The result was that workers were living in a state of anxiety, fearing cancer, birth defects and possible genetic damage for future generations.

We also remember the health suits, the spills, the fines, the leaks, the miscalibrations, the exposures, the criminal convictions and the one-celled organisms.

So when the NRC and GPU say that venting, dumping or burrying 2.1 million gallons of radioactive water will have a negligible impact on our health and environment ... people just don't believe them. Why should they? People live with in fear that they, and future generations, have suffered serious health effects as a result of the accident and GPU's mismanagement. This fear has fostered a great deal of psychological stress in our community. Stress can be translated into long term health effects, and is a very difficult to measure. Yet it is one factor the NRC will not identify in measuring health risks from the disposal of the water.

We are not scientists, and we do not feel that the burden of producing a safe, expedited method of disposal should fall on the shoulders of the community. The decision on what to do with this water should not be made in haste, and should not be made until all possible alternatives are explored and exhausted. People in this area have been dumped on enough. Were tired of being the guinea pigs.

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GPU Nuclear

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4410-87-L-0050
Document ID 0165P

March 25, 1987

Michael T. Masnik
Three Mile Island Cleanup Project Directorate
Office of Nuclear Reactor Regulations
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Masnik:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Comments of Draft Supplement 2 to the
Programmatic Environmental Impact Statement - Three Mile Island Unit 2

GPU Nuclear letter 4410-87-L-0032 dated March 17, 1987, provided comments on Draft Supplement 2 to the Programmatic Environmental Impact Statement - Three Mile Island Unit 2 (PEIS). Our purpose in providing those comments was to clarify, for the record, the differences in methodologies used by the NRC and GPU Nuclear in arriving at similar off-site dose consequence conclusions as published in the PEIS and GPU Nuclear letter 4410-86-L-0114 dated July 31, 1986, respectively. Coincidentally, the comments provide a basis to respond to inquiries concerning the variations in the published dose estimates. However, it is essential that the record reflect GPU Nuclear's unqualified endorsement of the NRC conclusion that disposal of the accident-generated water can be accomplished without incurring significant environmental impact.

Sincerely,

F. R. Standerfer
Director, TMI-2

FRS/JJB/eml

cc: Director - TMI-2 Cleanup Project Directorate, Dr. W. D. Travers

GPU Nuclear Corporation is a subsidiary of the General Public Utilities Corporation

This paper consisting of eight pages is submitted by me for consideration by the authorities in determining the best way to dispose of 2.1 million gallons of contaminated water at Three Mile Island-2 nuclear power reactor.

Karl Z. Morgan

Dr. Karl Z. Morgan

Signed and sworn before me by DR. KARL MORGAN this 23rd day of March, 1987.
My commission expires on the ____ day of ______________

SIGNED:

Linda L. DeBenedictis

Notary Public, DeKalb County, Georgia
My Commission Expires June [illegible]
3 23 87

Comments Relative to Treatment and Disposal of
2,100,000 gal. of Contaminated Water at TMI-2

by
Karl Z. Morgan
March 19, 1987

Qualifications to Express an Opinion

1- As far as I can determine I am the first person to publish a paper showing how to calculate dose from internal exposure to ionizing radiation and the standards of MPC ("Tolerance Concentrations of Radioactive Substances", by K Z Morgan, J. Phys. & Colloid Chem. 51, 984, 1947.

2. I was chairman of the Internal Dose Committees of both ICRP and NCRP for about two decades

3- I have worked with and researched ionizing radiation and health physics problems for over 50 years.

Material Reviewed in Preparing these Comments.

1- NUREG-0683 Sup No. 2 (draft report)
2- GPU Nuclear Corp. Attachment 4410-87-L-0033
3- GPU Nuclear Corp. Attachment - 4410-86-L-0175
4- NCRP Commentary No. 4 "Guidelines for the Release of Waste Water from Nuclear Facilities with Special Reference to the Public Health Significance of the Proposed Release of Treated Waste Waters at TMI 1987.

Comments

My comments are very brief because I have been able to spend only two days on this review.

Comment on NCRP Comm. No 4 Report

I believe that although the task group that prepared this report contained some experts in the area of radioactive waste disposal (e.g. F. L. Parker, J. W. Healy and D. G. Jacobs), the final conclusions should not be accepted in the decision to dispose of radioactive water by the methods proposed by GPU [illegible] very complicated. I agree with their [illegible] tion of the evaporation the vapor should not be released up the 50 meter stack but pumped to the 11,000 gal. condensate test tanks. Discharging the condensate via mixing with the 22,000 gal per minute blowdown water from the draft cooling tower is far better than direct discharge to the river but I am opposed to this method of disposal. I urge that rather investigation be made of disposal of the 9.1x10^6 gal of water by one of the following methods listed in decreasing order of preference:

1- Load the water (condensed vapor) into tank cars and ship and transload on a boat for disposal at sea. This would provide a lasting & perfect means of disposition. This method of sea disposal should receive no serious challenge by those concerned with our International Agreements Regarding Sea Disposal* because of the relatively low level of radioactivity and predominance of H-3. Using this method of disposal the insult to the marine environment and to man would be orders of magnitude less than those posed by the English operations near Seascale where they discharge radioactive waste into the Irish Sea. The shipment of the 490 carloads using 5000 gal tank cars should present no serious risks.

2- Load the water (condensed vapor) in 5000 gal tank cars and send to a site prepared to dispose of the water by deep-well injection. Considering there will be very little solid material in this condensate, deep-well disposal is made to order.

3- Dispose of the water (condensed vapor) by shipping in 5000 gal tank cars to a site prepared to dispose of it by the hydrofracture method.

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*One of these is that of the London Dumping Convention, 1972-1975

Comments on the NUREG-0683 Supp. Vol. 2 Report and the Two GPU Attachments

These reports as well as the NCRP report underestimate three-fold the discussions the dose to the individual of [illegible] and the population dose (person rem). The NCRP report is doubly at fault in that it uses a value of 0 (the cancer coefficient = cancers (either incidence or mortality) = 10^{-4} cancers/person-rem) which I and many others in this field believe is low at least by one order of magnitude, i.e. the value should be no less than 10^{-3} cancer deaths per person rem (See the chapter p 216-227 of the Encyclopedia Britannica, "Hazards of Low Level Radiation" by K Z Morgan. Copy attached).

This NUREG report gives in table No. 2.5 of the NRC concentrations in air and water (above background) that are acceptable in restricted areas. Below I reproduce the first and third columns from this table but add the EPA values (equivalents) that are based on the EPA limit of 4 mrem/y to the total body for drinking water. Values are not given by EPA for bone so in this table I increased the value for bone from 4 mrem per year (for total body) to (30/5) x 4 = 24 mrem/y because the ICRP-2 limit for occupational exposure to bone is 30 rem/y and the limit for total body is 5 rem/y.

Isotope		Water Activity Limit of NRC (μCi/cc)	Water Activity Limit of EPA (μCi/cc)
H-3	S-TB	3×10^{-3}	2.4×10^{-5}
	I	3×10^{-5}	—
	Sub	—	—
Cs-137	S-TB	2×10^{-3}	1.6×10^{-7}
	I	4×10^{-5}	—
Sr-90	S-B	3×10^{-7}	3.2×10^{-9}
	I	4×10^{-5}	—

S-Soluble, I-Insoluble, TB-Total Body, B-Bone

Here it is noted there is essential agreement for H-3 but the NRC value is 125 times the EPA value for Cs-137 and 12,500 times the equivalent value for Sr-90.

When two Government Agencies differ to such [illegible] in evaluating an [illegible] risk, I believe the agencies [illegible] in the [illegible] of safety should insist the more conservative agency [illegible] and the one in this case established to protect man and the environment takes precedence.

Now a look a quick look at Tables 2.2 and 2.3 in NUREG-0683 Sup. No. 2 and the tables in the [illegible] Attachment. The data in these tables were [illegible] confusing. Below in columns 2 & 3 (1st [illegible]) data from these tables. Where the values in these [illegible] differ, [illegible] in column 3 the [illegible] was [illegible] last. [illegible]

Radionuclides (Fw) (Effective Half Life)	Base Case	Achievable Values
H-3 (~10 days in [illegible])		
Activity (µCi/cc)	0.13	0.13
Dose Est. (mrem): NUREG-0683-2	7.8 (a) TB	7.8 [illegible] TE
One year dose from continuous exposure	10,6[illegible] E	
70 year dose from continuous exposure	7.7×10^5 TB	
Dose from 1 day's intake of 1000 cc water	14 (b) TE	
Dose from 1 day's intake of 2200 cc water/day	32 TB	
Cs-137 (~1[illegible] days in [illegible] half life)		
Activity (µCi/cc)	3.7×10^-5	4.0×10^-6
Dose Estimates (mrem): NUREG-0683-2	(a) 6.6 TB, 3.0 B	0.29 TB, 0.32 E
One year dose from continuous exposure	947 TB	
70 year dose from continuous exposure	90,300 TB	
Dose from 1 day's intake of 1000 cc water	(b) 1.6 TB	
Dose from 1 day's intake of 2200 cc water	3.6 TB	
Sr-90 (~[illegible]/25.3 years in bone)		
Activity (µCi/cc)	1.1×10^-4	1.0×10^-5
Dose Estimates (mrem): NUREG-0683-2	(a) 960 B, 19 TB	87 E, 1.2 TE
One year dose from continuous exposure	57,600 B	
70 year dose from continuous exposure	137,000,000 B	
Dose from 1 day's intake of 1000 cc water	(b) 3,680 B	
Dose from 1 day's intake of 2200 cc water	8,090 B	

[illegible]	[illegible]
Ru-106 ([illegible]) ([illegible] days in Kidney)	
Activity (μCi/cc)	$<3.1\times10^{-6}$
Dose estimates (mrem):	
NUREG-0693-2	—
One year dose from continuous exposure	< 12, K
70 year dose from continuous exposure	< 830, K
Dose from 1 day intake of 1000 cc of water	< 0.015, K
Dose from 1 day intake of 2200 cc of water	< 0.032, K
Dose to GIT(LLI) from 1 yr continuous exposure	< 47, GIT
Ce-144 ([illegible]) ([illegible] days in Bone)	
Activity (μCi/cc)	$<1.8\times10^{-6}$
Dose estimates (mrem):	
NUREG-0693-2	—
One year dose from continuous exposure	< 2.7 B
70 year dose from continuous exposure	< 532, B
Dose from 1 day intake of 1000 cc of water	< 0.010, B
Dose from 1 day intake of 2200 cc of water	< 0.021, B
Dose to GIT(LLI) from 1 yr continuous exposure	< 27, GIT
Co-60 ([illegible]) ([illegible] days in Total Body)	
Activity (μCi/cc) GPU	4.8×10^{-7} TB
Dose estimates (mrem)	
NUREG-0693-2	—
One year dose from continuous exposure	1.67, TB
70 year dose from continuous exposure	132, TB
Dose from 1 day intake of 1000 cc of water	0.002, TB
Dose from 1 day intake of 2200 cc of water	0.005, TB
Dose to GIT(LLI) from 1 yr continuous exposure	1.44 GIT
Pu-239 ([illegible]) (121,000 days in Bone)	
Activity (μCi/cc) GPU	$<1.4\times10^{-8}$ E
Dose Estimates: (mrem)	
NUREG-0693-2	—
One year dose from continuous exposure	< 0.34, B
70 year dose from continuous exposure	< 1098, B
Dose from 1 day intake of 1000 cc of water	< 0.17 B
Dose from 1 day intake of 2200 cc of water	< 0.38, B
Dose to GIT(LLI) from 1 yr continuous exposure	< 0.07, GIT

TB - total body
B - bone
K - kidney
GIT(LLI) - Gastro-intestinal tract (lower large intestine)

and I made a number of calculations (using a [illegible] using a [illegible] calculator) and entered some of the results in the above table. All the values are for the adult (standard or reference man). The doses in [illegible] not [illegible] would have been considerably [illegible] to the [illegible] (b) but I have not had time to make these calculations. The dose values marked (a) given in NUREG should check with my calculated values of [illegible] (b) but I will be noted two of my values 14 mrem for H-3 and 3,680 mrem for Sr-90 are larger than the NUREG values, that are 7.8 mrem for H-3 and 960 mrem for Sr-90. My value of 1.6 mrem for Cs-137 is lower than the NUREG value of 19.6 mrem. These differences should be investigated. These values are for an intake of 1000 cc of the processed water. I don't know why the NRC staff used only one intake of 1000 cc. The standard man consumes 2200 cc per day so I made these calculations obtaining 30 mrem for H-3 and 3.6 mrem to total body from Cs-137. Note that these values of one days intake should be compared with the EPA limit of 4 mrem for drinking water. The equivalent EPA values for bone and kidney are (30/5) x 4 = 24 mrem and (15/5) x 4 = 12 mrem where 30 rem/y, 5 rem/y and 15 rem/y are the limiting dose rates for bone, total body and kidney respectively for the occupational worker.

I looked at three radionuclides, Sr-90, Ce-144 and Pu-239 for which bone is often the critical body organ. Here it is noted the values for Sr-90 (3680 mrem from 1 days intake of 1000 cc or 8,090 mrem for 1 days intake of 2200 cc) far exceed the EPA equivalent limit of 24 mrem per year, and most of this dose is in the first year after intake. The GPU provides no data for activities of Ru-106, Ce-144 or Pu-239 but their limit of detection is adequate for a single intake of 1000 cc or 2200 cc (i.e. 0.015 mrem and 0.033 mrem are < 12 mrem and 0.01 mrem, 0.021 mrem, 0.17 mrem and 0.38 mrem are less than the 24 mrem/year bone dose limit).

It seems to me that an evaluation of the dose from one days intake of 1000 cc or 2200 cc of processed water does not strike at the more meaningful evaluation of [illegible] intake of the processed water. For continuous intake for one year the doses are 10,000 mrem for H-3, 947 mrem for Cs-137, 157,600 mrem for Sr-70, < 12 mrem for Ru-106, < 2.7 mrem for Ce-144, < 1.67 mrem for Co-60 and < 0.24 mrem for Pu-239. Were a standard man to consume this water for 70 years at the projected level of contamination at discharge, the doses would be 770,000 mrem for H-3, 90,300 mrem for Cs-137, 137,000,000 mrem for Sr-90, < 930 mrem for Ru-106, < 532 mrem for Ce-144, 122 mrem for Co-60 and < 1098 mrem for Pu-239. Thus it is seen that levels below the limit of GPU detection would be far in excess of a safe level for consumption of the water for 70 years.

Finally I looked at the dose to the GIT from one year's consumption of Ru-106, Ce-144, Co-60 and Pu-236. The values respectively are < 47 mrem, < 27 mrem, 1.14 mrem and < 0.07 mrem. Thus in all these cases the GIT is not the organ of highest dose.

In Conclusion

I believe that the studies made by GPU and by the NRC staff are woefully inadequate and much more data should be provided before deciding the best way to be rid of this problem, i.e. before deciding to let go of the bear we have by the tail.

Karl Z. Morgan

[illegible]

Dose Rate

$$R(\text{mrem/y}) = q(\mu Ci)\,3.7\times10^{4}(\text{dis/s}\,\mu Ci)\,EQN(\text{MeV/dis})$$
$$\times 1.602\times10^{-6}(\text{erg/MeV})\,\frac{1}{m}(1/g)\,10^{3}(\text{mrem/rem})\times 3600\times24\times365(s/y)$$
$$\times 1/100\,(g\,rad/erg) = \frac{1.87\times10^{7}\,EQN\,q}{m}\ \text{mrem/y} \qquad (1)$$

Dose from a Single Intake

$$D = \int_0^t R e^{-\lambda t}dt = \frac{R}{\lambda}(1-e^{-\lambda t}) = \frac{1.87\times10^{7}\,EQN\,q}{m\lambda}(1-e^{-\lambda t})\ \text{mrem} \qquad (2)$$

Dose from Continuous Intake

$$\frac{dq}{dt} + \lambda q = P$$
$$q = \frac{P}{\lambda}(1-e^{-\lambda t})$$
$$P = i(cc/y)\,f_w \times C(\mu c/cc) = 2200(cc/d)\,365(d/y)\,f_w C = 8.03\times10^{5} f_w C$$
$$D = \int_0^t \frac{1.87\times10^{7}\,EQN\times8.03\times10^{5} f_w C}{m\lambda}(1-e^{-\lambda t})dt =$$
$$D = \frac{1.50\times10^{13}\,EQN\,f_w C}{m\lambda}\left(t + \frac{e^{-\lambda t}}{\lambda} - \frac{1}{\lambda}\right)\ \text{mrem} \qquad (3)$$

Dose from One Day's Intake after Exposure of t Years

$$q_1 = 2200 f_w C$$
$$D = \int_0^t \frac{1.87\times10^{7}\,EQN\,2200 f_w C}{m}e^{-\lambda t}dt$$
$$D = \frac{4.11\times10^{10}\,EQN\,f_w C(1-e^{-\lambda t})}{m\lambda}\ \text{mrem} \qquad (4)$$
$$D = \frac{4.11\times10^{10}\,EQN\,f_w C}{m\lambda}\ \text{mrem for } t\to\infty \qquad (4)'$$

Dose to Lower G.I. Tract (Colon) from One Year's Continuous Exposure at ICRP-2 MPC Level

$(MPC)_{LLI}^{168hr}$ corresponds to $R = 15000$ mrem/y dose rate when exposure time, t, is >> 18 hours.

$$D = \frac{C\times1500}{(MPC)_{LLI}^{hr}}\ \text{mrem} \qquad (5)$$

GPU Nuclear

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4410-87-L-0018
Document ID 0068P

February 3, 1987

Document Control Desk
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Sirs:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Disposal of Processed Water

Attached for your information are results of analyses performed for GPU Nuclear by the Westinghouse Advanced Energy Systems Division Analytical Laboratories. These analyses were performed as part of the waste stream classification requirements of 10 CFR Part 61. They provide additional information regarding the radionuclide content of selected processed water streams at TMI-2. This data was not available prior to publication of Draft Supplement 2 to the Programmatic Environmental Impact Statement - Three Mile Island Unit 2 (PEIS).

The data provided in the attachment is representative of the radionuclide inventory of TMI-2 water which has undergone processing. In accordance with our July 1986 proposal for the disposal of TMI-2 water by the evaporation process, this water would not be reprocessed prior to evaporation. Therefore, these data are representative of the influent stream to the evaporation system and are provided for your consideration in that context. Similar data is not reported by Westinghouse for tritium (H-3) since an analysis for tritium was not performed. The data reported in our July 1986 proposal for the "Disposal of TMI-2 Water" remains valid.

Sincerely,

/s/ R. E. Rogan for

F. R. Standerfer
Director, TMI-2

GPU Nuclear Corporation is a subsidiary of the General Public Utilities Corporation

FRS/JJB/eml

Attachment

cc: Regional Administrator - Region 1, Dr. T. E. Murley
Director - TMI-2 Cleanup Project Directorate, Dr. W. D. Travers

ATTACHMENT
4410-87-L-0018

WESTINGHOUSE ADVANCED ENERGY SYSTEMS DIVISION ANALYSES

	CCT-1 85-10962 09/18/85 86-2007		CCT-2 85-11240 09/26/85 86-2008		PWST-1 85-15995 12/20/85 86-2009		PWST-2 85-16198 12/23/85 86-2010	
	uCi/ml	2S	uCi/ml	2S	uCi/ml	2S	uCi/ml	2S
Co-60	1.2E-7	8.4E-8	< 4.5E-8		< 1.0E-7		1.8E-7	5.2E-8
Ag-110m	< 3.6E-7		< 1.2E-7		< 2.3E-7		< 1.1E-7	
Sb-125	< 3.3E-7		< 1.1E-7		< 2.7E-7		3.4E-7	1.1E-7
Ru-106	< 1.1E-6		< 5.3E-7		< 9.8E-7		< 5.2E-7	
Cs-134	3.2E-7	1.2E-7	1.2E-7	4.5E-8	2.4E-7	8.1E-8	2.1E-7	4.4E-8
Cs-137	6.5E-6	2.5E-7	2.8E-6	7.6E-8	6.4E-6	2.2E-7	4.8E-6	9.9E-8
Ce-144	< 7.8E-7		< 3.0E-7		< 5.7E-7		< 2.8E-7	
Sr-90	9.0E-6	1.8E-7	1.8E-7	3.6E-8	7.9E-6	1.8E-7	2.1E-5	2.9E-7
I-129	< 4.8E-7		< 5.3E-7		< 6.2E-7		< 5.9E-7	
Ni-63	< 5.4E-7		< 5.2E-7		8.4E-7	6.5E-7	< 5.6E-7	
Tc-99	< 2.6E-7		< 2.7E-7		9.9E-7	3.2E-7	< 2.5E-7	
C-14	1.4E-4	9.8E-6	1.1E-4	1.1E-5	5.1E-5	6.2E-6	3.0E-4	1.1E-5
U-234	< 1.1E-8		< 1.4E-8		< 1.6E-8		< 1.5E-8	
U-235	< 6.2E-9		< 6.9E-9		< 1.2E-8		< 8.7E-9	
U-238	< 8.4E-9		< 8.1E-9		< 1.2E-8		< 1.4E-8	
Pu-238	< 1.1E-7		< 1.2E-8		< 1.2E-8		< 1.1E-8	
Pu-239/240	< 3.7E-8		< 1.3E-8		< 1.4E-8		< 1.2E-8	
Am-241	< 4.6E-8		< 1.2E-8		< 1.2E-8		< 1.1E-8	
Cm-242	< 1.1E-7		< 8.6E-8		< 6.3E-8		< 6.1E-8	
Cm-243/244	< 2.0E-8		< 1.0E-8		< 1.1E-8		< 8.6E-9	

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GPU Nuclear

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4000-87-S-059
Document ID 0023P

February 20, 1987

Mr. Arthur E. Morris
Chairman, The Advisory Panel for the Decontamination
of Three Mile Island Unit 2
P.O. Box 1559
Lancaster, PA 17603

Dear Chairman Morris:

Subject: Disposal of Processed Water

Attached for your information is a copy of a letter we have sent to the NRC providing additional information with respect to the radiochemistry of the TMI-2 Processed Water. We will be prepared to discuss this information with you in detail at the upcoming Advisory Panel Meeting on February 26, 1987.

Sincerely,

F R Standerfer

F. R. Standerfer
Director, TMI-2

FRS/eml

Attachment

cc: Advisory Panel Members

175

GPU Nuclear

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4410-87-L-0023
Document ID 0068P

February 18, 1987

US Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Dear Sirs:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Disposal of Processed Water

The purpose of this letter is to provide you the results of GPU Nuclear's recent assessment of radionuclides which may be present in the processed water at TMI-2.

As discussed in GPU Nuclear letter 4410-86-L-0114 dated July 31, 1986, which requested NRC approval for disposal of processed water at TMI-2, certain radionuclides will be present in the evaporator effluent. Specifically, that submittal evaluated the population and environmental effects of tritium (H-3), strontium-90, and cesium-137.

GPU Nuclear letter 4410-87-L-0018 dated February 3, 1987, forwarded the results of analyses performed for GPU Nuclear by the Westinghouse Advanced Energy Systems Division Analytical Laboratories. That submittal provided additional information regarding the radionuclide content of selected processed water streams at TMI-2. Because these analyses provided information that was not previously available, GPU Nuclear undertook a comprehensive review of the radionuclides potentially present in the processed water and, based on the disposal scenario described in the July 31, 1986 submittal, may be a constituent of the evaporator influent.

A.43

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As part of this review, GPU Nuclear developed a list of particulate radionuclides (see attachment) based on the following criteria:

1. Radionuclides specifically identified in 10 CFR Part 61.
2. Greater than 0.1% of the core isotopic content, on a curie basis, eight (8) years following the TMI-2 Accident as determined by the ORIGEN computer code.
3. Greater than 0.1% of the core transuranic inventory, on a curie basis.
4. Reactor Coolant System activation products of practical interest as identified by the Babcock and Wilcox Water Chemistry manual.

Additionally, the attachment provides an assumed average concentration of each radionuclide potentially present in the evaporator influent (i.e., total curie content of the radionuclides in the various water sources divided by the total volume of processed water). In developing this list, GPU Nuclear used lower limits of detection (LLD) or the actual measured activities for the radionuclides listed. The activity of radionuclides for which no data were available were estimated by various means. For example, the europium, samarium, and promethium values were based on a ratio between the core isotopic ratios given by ORIGEN and the known LLD of Ce-144. This provides a maximum activity which could be present in the presence of no greater than LLD activity of Ce-144. This is a reasonable approach since these elements are all rare earths and are chemically similar. It should be noted that the concentrations listed on the table are average concentrations. Actual concentrations in specific water sources may vary from that listed.

Using the radionuclide concentrations listed, GPU Nuclear conducted a comparative evaluation of the potential off-site effects of these radionuclides, relative to Sr-90, based on the total dose commitment resulting from the ingestion pathway or summation of all pathways as available in the references. The dose due to exposure to the plume was not considered for this analysis since its contribution to an individual's total dose is several orders of magnitude less than the ingestion pathway. As noted in Section 8.1 of our July 31, 1986, submittal, Sr-90 was used as the basis for the relative assessment since it is the most radiologically significant radionuclide.

Based on the above assessment, the potential impact of each radionuclide was derived by multiplying the known or calculated activity or the LLD listed on the attachment by pathway dose conversion factors from the TMI-2 Off-site Dose Calculation Manual or the Total Dose Commitment values from EPRI NP 3840 to obtain an indication of the relative impact of the isotope (see Attachment). Based on this review, three (3) additional isotopes were identified for which the off-site dose contribution exceeds 1% of the off-site dose from Sr-90. These isotopes are C-14, Tc-99, and I-129. However, values listed can only be considered an indication of the order of magnitude of the relative impact. The difference in critical organ for the various radionuclides makes direct addition of the ratios incorrect. For example, although I-129 is estimated to have an approximate impact of 19% when compared to Sr-90, it does not indicate that the dose to the individual would increase by 19%; the critical organ dose calculated for Sr-90 is applied to the bone whereas the dose from I-129 would be to the thyroid.

With the exception of the special case of I-129, as noted above, this analysis also reaffirms that the LLD's established for the various radionuclides listed herein are sufficiently low to ensure that the environmental impact at those concentrations would be insignificant (i.e., less than 1% of the relative contribution from Sr-90).

Considering the potential contribution of these three additional radionuclides to off-site dose resulting from disposal of the TMI-2 processed water by evaporation, GPU Nuclear has concluded that the off-site environmental consequences remain well below regulatory limits (i.e., 10 CFR 50, Appendix I) and the potential impact to the population and the environment remains insignificant. We are confident that your analysis of these data, in support of finalization of the PEIS, will support this conclusion.

Sincerely,

/s/ F. R. Standerfer

F. R. Standerfer
Director, TMI-2

FRS/JJB/eml

cc: Regional Administrator - Region 1, Dr. T. E. Murley
Director - TMI-2 Cleanup Project Directorate, Dr. W. D. Travers

ATTACHMENT
4410-87-L-0023

AVERAGE CONCENTRATION OF RADIONUCLIDES POTENTIALLY PRESENT IN TMI-2 WATER FOR EVAPORATION

Radionuclides	Concentration (uCi/ml)	Relative Off-site Dose Impact Compared to Sr-90
H-3	1.3 E-1	<0.01 [2]
C-14	1.0 E-4	0.50 [3]
Mn-54	<4.0 E-8	<0.01
Fe-55	4.8 E-7 [1]	<0.01
Co-58	<4.0 E-8	<0.01
Co-60	4.8 E-7	<0.01
Ni-63	<6.0 E-7	<0.01
Zn-65	<9.8 E-8	<0.01
Sr-90/Y-90	1.1 E-6	1.00
Tc-99	1.0 E-6	0.20
Ru-106/Rh-106	<3.3 E-7	<0.01
Ag-110M	<5.6 E-8	<0.01
Sb-125/Te-125m	2.3 E-6	<0.01
I-129	<6.0 E-7	0.19[4]
Cs-134	8.8 E-7	<0.01
Cs-137/Ba-137m	3.6 E-5	<0.01
Ce-144/Pr-144	<2.1 E-7	<0.01
Pm-147	<4.8 E-6 [1]	<0.01
Sm-151	<1.1 E-7 [1]	<0.01
Eu-152	<3.8 E-10 [1]	<0.01
Eu-154	<4.4 E-8 [1]	<0.01
Eu-155	<1.1 E-7 [1]	<0.01
U-234	<1.0 E-8	<0.01
U-235	<1.2 E-8	<0.01
U-238	<1.2 E-8	<0.01
Pu-238	<1.2 E-8	<0.01
Pu-239	<1.4 E-8	<0.01
Pu-240	<1.4 E-8	<0.01
Pu-241	<6.5 E-7 [1]	<0.01
Am-241	<1.2 E-8	<0.01
Cm-242	<1.0 E-9	<0.01

[1] Calculated concentration

[2] H-3 ratio is based on food pathway. Since tritium is present in a gaseous form, it also has a inhalation pathway constituent. As total H-3 impact was evaluated in the July 31, 1986 submittal, it was not further evaluated here.

[3] Ratio listed is for C-14 if present in a carbonate or organic form. If C-14 is present as a dissolved gas (e.g., CO_2), the ratio would be <0.01.

[4] The relative off-site dose impact compared to Sr-90 listed for I-129 assumes it is present at LLD (i.e., 6.0 E-7); therefore, 0.19 is a maximum value. The actual relative off-site dose impact for I-129 would be less than this value.

[5] < means less than.

Susquehanna Valley Alliance
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(717) 394-2782

Dear Dr Masnik,

At their request,please accept the comments made by Dr Ernest Sternglass and Dr Richard Piccioni to the Citizens'Advisory Panel in Harrisburg on March 25th. 1987, as an official part of their comments on the NRC's supplement to their Environmental Impact Statement.

Thank you,

Frances Skolnick

Frances Skolnick
Coordinator,SVA.

Susquehanna Valley Alliance
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The Susquehanna Valley Alliance is a safe energy organisation whose membership mostly resides in Lancaster County, Pa. The organisation was formed as a direct result of the accident at Three Mile Island and the threat that the radioactive water from the accident would be dumped into the Susquehanna River, drinking water source for many citizens of Lancaster County.
Below are the comments of this organisation on the NRC's supplement to their Environmental Impact Statement.

We have read the comments of Dr Michio Kaku, Dr Karl Morgan, and Dr Carl Johnston. We accept their findings that this document is inadequate, shows major inaccuracies and displays a lack of scientific skill in its preparation. In light of this, we are unable to accept the NRC's findings that any method of disposal of this water will have little impact on our environment.

We understand that this document is a draft, however this is no excuse for the NRC to have omitted from the table of contents of this water, a list of all radionuclides, including transuranics. It was not until the SVA requested the list that the NRC mentioned these elements. This appears to be an attempt to misdirect the accurate attempts to analyse this document, and to fully determine the impact that any disposable method might have on the environment. This water covers the melted fuel and is therefore highly suspected of containing alpha radiation. Some transuranics, for example, plutonium, are highly toxic to man and have a long life. Plutonium is soluble in water and was found in the water in Denver which is downwind of Rocky Flats. So even though these elements may not be so abundant as strontium, cesium and tritium, it is essential that due to their toxicity to man, alpha sensitive radiation monitoring equipment is used to analyse the water now. Only then can an accurate assessment of the environmental impact of any disposal method be made.

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Aside from the possible transuranic content of this water,cesium, strontium and tritium will be released into our environment. These releases will be in addition to those releases imposed upon this population by the releases of the accident,the Krypton venting,the clean-up,and operations at Unit 1. These releases from any disposal method cannot be considered in isolation from all future releases from nuclear power plants,and indeed as we have seen from the events at Chernobyl, it is not only releases from local power plants that impact upon the population,but also releases from any plant anywhere.

Tritium is of special concern since there is no scientific proof that it is not harmful to the human organism. It is easily taken into the body by inhalation or ingestion. Indeed experiments have shown that laboratory animals have suffered cancer,birth defects and genetic mutations from exposure to tritium. It is extremely imprudent to disperse radioactive materials into our environment without having a full understanding of their effects on the human organism.

In the EIS(1981) the NRC discussed the problem that the chemicals used in the decontamination solutions and the oils and greases in the reactor vesselcould clogg the Epicor and SDS systems and cause them to work ineffectively especially towards the end of the clean-up after the fuel has been removed. This then would present a new problem in that the water may have a different content prior to going into the evaporator. This problem was neglected in the supplement.

Since the evaporation method is the preferred method of disposal by GPU Nuclear it would have been more appropriate for the NRC to give a more thorough understanding and evaluation of the system. It is unclear how long it takes for the system to close down when particulate matter begins to escape into the environment,and how much will escape before the system is completely closed off to the environment.

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Furthermore,how many workers will work solely at the evaporator system and tend to it while in operation. Also,we are not informed as to the optimum temperatures needed to boil the water and prevent the particulate matter from going into the stack and hence into the environment. We have no trust whatsoever in GPU Nuclear's ability to run the system with only the public's health and safety in mind.

This document mis-uses the words"small",minimum" and "fraction" when referring to radioactive materials and their effect. The words are meaningless to us and scientists around the world who can show with scientific proof that there is no safe level of radiation for the human organism. Therefore the problem is not with what the evaporator system can hold within the system but with the "small amounts" of radioactivity which will escape into the air which we breathe. We learn that "the fraction released would be dependent upon the concentration in the water input; the feed rate to the evaporator; the design of the evaporator;and the removal fraction from plate-out on the moisture seperator,ducts and stack" This turns out to be an abundance of variables affecting the possible release of radionuclides into our environment. In spite of this we are not informed by the NRC how these variables will be controlled or how they derived their conclusion that they "concur with this achievable level" It is obvious to us that GPU Nuclear is being given too much liberty in controlling this situation. This is outrageous in view of the leak rate falsification activities prior to the accident in 1979.

The NRC should have clearly stated in their document why there is an initial concentration of radionuclides in the accident generated water. Does this mean that we can expect a concentration of radionuclides each time the evaporator has been shut off for one reason and another and then started up again. Furthermore,the NRC neglected to make an analysis of the impact in the event of a malfunctioning of the evaporator system.

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We cannot accept the dispersal of radioactivity into our environment in light of the fact that there are other options available to contain this radioactivity. It is total insanity to sit and talk about boiling up water and allowing the radioactive waste free access to our bodies. This population has suffered sufficient damage at the hands of GPU Nuclear. There should be no further onslaught of radiation on their immune systems.

Frances Skolnick

Frances Skolnick
Coordinator SVA.

TMIA: THREE MILE ISLAND ALERT, INC.
315 Peffer St., Harrisburg, Penna. 17102 (717) 233-7897

April 11, 1987

Dr. Michael T. Masnik
TMI Cleanup Project Directorate
Division of PWR Licensing-B
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Masnik:

Three Mile Island Alert (TMIA) is a non-profit, safe energy organization formed by citizens in the community, following the construction and licensing of the Three Mile Island (TMI) nuclear power plant in 1977. We have represented community concerns in Nuclear Regulatory Commission (NRC) hearings on a broad spectrum of issues dealing with the licensing and operation of TMI Unit 1. As a public interest group dedicated to maintaining the integrity of the environment and to protecting public health and safety, we are opposed to any additional releases of radiation from the operation of Unit 1 or the cleanup of Unit 2.

TMIA has reviewed the NRC's draft supplement to the Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from March 28, 1979 accident Three Mile Island Nuclear Station, Unit 2 (NUREG-0683) and conferred with noted experts in the field of nuclear physics, radiation and health. This document is deficient in many areas and demonstrates the NRC's disregard for its mandate to protect the health and safety of the public.

TMIA rejects the revised EIS as irresponsible and unacceptable for many reasons.

- "Disposal" is actually an incorrect and misleading term. There will be no actual disposal of the radioactive water. Methods being considered are those that involve dispersal to, and contamination of, the environment.

- The EIS has listed an incomplete inventory of radionuclides actually found in the contaminated water. For example, the list of radionuclides on page 2.3, Table 2.2 of the revised EIS omits many important radionuclides originally listed in the first EIS, pages 7-5,7-6,7-7.

- Neither the revised EIS or the original have a complete accounting of the transuranics in the water.

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- The current EIS lists only 1,020 curies of tritium in the waste water, when the original count was 2,500 curies.

- Serious consideration was not given to the potentially hazardous health effects if tritium is incorporated into the body. It will become a long-term part of the body's chemistry, irradiating body tissues for the life-span of the individual. Current studies indicate that there will soon be conclusive evidence demonstrating that tritium is much more hazardous than previously thought.

- The release of tritiated water into the atmosphere by evaporation will cause the HTO to become part of our environment. It will enter into the food chain, and essentially become part and parcel of every living organism.

- Any method which involves additional radioactive contamination of the environment and radiation exposure to citizens, is unacceptable. The EIS neglects the fact that the population has been exposed for years, to radioactive emissions from TMI. Studies have documented the hazards associated with cumulative doses of low-level radiation, especially the increased chances of developing cancer.

- The EIS does not contain a meteorological study. Considering that evaporation seems to be the preferred method of the utility, wind patterns need to be studied. Controlled evaporation methods should assure that certain segments of the population do not receive concentrated doses due to weather patterns and prevailing winds.

- The EIS does not address the impact of psychological stress on citizens living in the surrounding communities.

- Potential economic loss on the part of citizens whose businesses may be affected by the method of disposal, has not been evaluated. For example, the Central Pennsylvania area is a major eastern tourist center (Hershey, Pennsylvania Amish, etc.). Many businesses may be hurt if people decide not to bring their families to a vacation spot where they will be exposed to radioactive emissions. The sale of agricultural products will be affected, since consumers may be wary of radioactive contamination. If river dumping is allowed, there is the potential for adverse effects on the seafood industry of the Chesapeake Bay.

The revised EIS is a shockingly incomplete, inadequate, insubstantial and misleading document.

The NRC has not mentioned in the EIS or in any other document, any intent to closely monitor methods used by the utility and its vendors. This is a utility that has in its history, a record of deception, falsification and destruction of documents, employee harassment, equipment malfunction, and other examples that demonstrate a lack of integrity.

TMIA urges the Commission to disapprove NUREG-0683, the EIS Supplement, and to order a complete and reliable scientific study of environmental impacts. In addition, we request that until a method of dealing with the radioactive waste water is found, that involves no environmental release, the water be contained on site, in continuous monitored storage.

Sincerely,

Vera L. Stuchinski

Vera L. Stuchinski
Chairperson
Three Mile Island Alert
315 Peffer Street
Harrisburg, PA 17102

cc: Commissioner Zech
Commissioner Roberts
Commissioner Asselstine
Commissioner Carr
Commissioner Bernthal

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Nuclear

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4410-87-L-0036
Document ID 0143P

April 14, 1987

Michael T. Masnik
Three Mile Island Cleanup Project Directorate
Office of Nuclear Reactor Regulations
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Masnik:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Comments on Draft Supplement 2 to the
Programmatic Environmental Impact Statement - Three Mile Island Unit 2

The purpose of this letter is to provide additional information, not previously available, for your consideration in development of the Final Supplement 2 to the Programmatic Environmental Impact Statement - Three Mile Island Unit 2 (PEIS). It also responds to previously expressed concerns relative to the potential for release of particulates to the atmosphere during the proposed evaporation process.

GPU Nuclear has received process-specific data concerning the potential for particulate releases during the evaporation process. These data are based on information recently received from the several vendors proposing systems for use at TMI-2. The information indicates that the potential for particulate release, due to the sodium and boron concentrations present in the processed water, ranges from essentially no release to a maximum of 5.3×10^{-6} pounds (3.7×10^{-2} grains) of particulate per dry standard cubic foot of evaporator

GPU Nuclear Corporation is a subsidiary of the General Public Utilities Corporation

stack effluent. This is much less than the conservatively estimated 1% maximum particulate carryover previously discussed in the GPU Nuclear environmental statement.

Sincerely,

F. R. Standerfer
Director, TMI-2

FRS/JJB/eml

cc: Director, TMI-2 Cleanup Project Directorate - Dr. W. D. Travers

Comments on the Draft Supplement to the Programmatic Environmental Impact Statement Regarding Disposal of Accident-Generated Water From Three Mile Island Unit 2

NUREG-0683 Supplement No. 2 says it explores the decontamination and disposal of radioactive waste (water) from the March 28, 1979 accident at TMI. It purports to exhaust the subject, when actually it has overlooked many of the most important considerations.

It does not discuss decontamination other than to say it expects all the accident-generated water to be reprocessed by the SDS and Epicor II systems. The public does not believe that this will decontaminate the water of all transuranics and all but seven elements. I cannot believe that the water has washed the degraded fuel and has shielded the radioactive sludge for years without being loaded with many other dangerous elements which didn't wash out of the system.

I am not sure that the chemicals in the mix are not radioactive. In the 1981 EIS it was stated that "fines" could delay the cleanup. "Fines" were defined as minute particles with a radioactive burden which could not be filtered out of the water. Could some of these particles be chemicals?

There is no assurance that the micro-organisms that grow wildly in the radioactive hot water will be killed before the water is dispersed. Can we be sure that they would not create a health hazard?

While the alternatives have been presented at length, the environmental impacts in the TMI area have been dismissed in many cases with a sentence or two.

For instance, the option to dump the water in the Susquehanna says little about the number of dams downstream which collect silt and could intensify the build-up of any contaminants. It dismisses the impact on the fish which support an enormous industry in the Chesapeake Bay. A privately funded study of the impact of TMI on the Susquehanna by the TMI Health Fund has apparently not been consulted. It would have been a good idea to find out what radioactivity has already done to this river. This could also have included the effects of the Susquehanna and Peach Bottom nuclear plants.

The TMI area lies in a river basin surrounded by hills which trap the air. It is subject to fog and to inversions. This meteorology, coupled with a relatively high density of population has led to restrictions on burning of trash in the area. Yet, there is not one mention of these factors in the EIS.

The draft does not discuss the fact that the prevailing winds carry radioactive water toward one group of people more often than not. The population on the hillside, on an elevation even with the top of the stacks, downwind, already feels it has suffered severe health effects fromthe accident and clean-up. Air dispersal would impact these people more than others.

Important to all of us is the fact that any dispersal of this radioactive water is just that much more radioactivity when we have already had enough. No-one has given us an accounting of how much radioactivity we got from the accident, from venting, and from cleanup, not to mention the operation of Unit 1 before and after the accident. This EIS does not do that either.

The draft talks about inconsequential effects of radiation on the one hand and fatalities from cancer or traffic accidents on the other. Where is the discussion of cancer incidence, genetic effects, or increased susceptibility to chronic diseases?

Except for the effects of drinking the water, little is said about the disproportionate effect of radiation on the fetus or the developing child.

Most importantly, none of the alternatives presented actually disposes of the radioactive water. Real disposal would effectively isolate the radioactivity from the biosphere. All the alternatives in this draft except for the No-Action alternative effectively disperse the radioactivity rather than isolate it.

This is truly ironic because apparently the main reason the NRC has presented an EIS is to satisfy the TMI public which objects to any more radioactivity being dispersed into its environment.

Why is the alternative presented in this draft which seems to do all the right things for the public rejected?

The No-Action Alternative of Liquid Storage in Tanks On-Site:

1. Does not pollute the downstream water supplies
2. Does not force the public to breathe radioactive vapor
3. Could cost as little as zero dollars
4. Would not create additional occupational exposure
5. Would have no significant exposure pathways to the public other than from accidents (which the draft minimizes)
6. Would require no additional land commitment
7. Would take no transportation risks.

How can the NRC say "no?" The only explanation given is that the NRC feels it merely defers disposal. The people around TMI do not want to see this alternative dismissed with a word like "merely."

1. It would allow most of the stated radionuclides to have passed through 10 half-lives, to have practically disappeared by disintegration.

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2. It would allow Strontium-90 (28.5 years) and Cesium-137 (30.2 years) to have disintegrated through one full half-life.

3. It would allow a whole generation which has experienced the accident, the venting and the cleanup to age without more irradiation.

Only two reasons are given by the NRC for not considering this option.

1. The NRC has made a policy decision not to make TMI a nuclear waste dump. The public applauds this decision. Unfortunately it is not entirely honest because no-one plans to dismantle and carry off the present plants nor to abolish the pool of used fuel rods. So why would the NRC worry about a little radioactive water which they do not consider dangerous?

2. It creates an administrative problem for the NRC by putting off a "final" decision, perhaps beyond the date of the license expiration.

I believe that the NRC simply wants to make the water "disappear" so that 30 years from now the public will not be reminded that the accident happened and it didn't go away.

Whatever scientific evidence is presented in this draft I believe is essentially irrelevant. What we are commenting on is public policy.

Deliberately dumping nuclear wastes on the public in any quantity is bad public policy in a democracy. Dumping them on a public which has already been traumatized and had its health endangered by a nuclear accident is completely unacceptable.

I urge the NRC to reconsider - to contain the water, not disperse it- at TMI or anywhere else.

- Beverley Davis
200 Gettysburg Pike
Mechanicsburg, PA 17055

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
EXTERNAL AFFAIRS

APR 24 [illegible]

Dr. Michael T. Masnik
TMI Project Directorate
Office of Nuclear Reactor
  Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Masnik:

In accordance with Section 309 of the Clean Air Act and our responsibilities under the National Environmental Policy Act, the U.S. Environmental Protection Agency (EPA) has reviewed the U.S. Nuclear Regulatory Commission's (NRC) Draft Supplement No. 2 to the Programmatic Environmental Impact Statement (EIS) related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979, accident at Three Mile Island (TMI) Nuclear Station, Unit 2. This draft supplement (NUREG-0683) addresses the environmental and health impacts of disposal of water generated by the accident or used for cleaning up after the accident. The draft supplement identifies a number of potential alternatives for disposal of the water. These include on-site and off-site evaporation, direct solidification, continued on-site storage, and discharge of the water to the Susquehanna River after further treatment.

After extensive review and analysis, EPA has concluded that there are no significant radiation impacts from the proposed alternatives identified in the draft supplement. For each of these alternatives, NRC's calculated dose exposures are below regulatory limits set by EPA and/or NRC. EPA has therefore rated this draft supplemental EIS LO, indicating a Lack of Objections to the proposed alternatives.

However, because this action involves a new non-routine discharge, EPA recommends that NRC not select either of the alternatives involving discharges to the Susquehanna River. An extraordinary national and multi-institutional (federal and state) effort is presently being implemented toward the restoration and protection of the Chesapeake Bay and its tributaries, including the Susquehanna River. A fundamental part of this restoration effort is to reduce the pollutant burden flowing into the Bay. Therefore, as a general rule, we believe that if there are viable alternatives to such non-routine discharges to the Bay or its tributaries, they should be given great weight.

Finally, because of public concerns regarding TMI and our desire to ensure that the NRC presents the most accurate description possible of the consequences of choosing any particular alternative, we are providing detailed comments to help clarify the basis for NRC's decision-making process.

I have asked Dr. William Kirk (FTS: 590-3909), Director, EPA Three Mile Island Field Station, and John R. Pomponio (FTS: 597-1181) of the Region III staff to provide any needed assistance to you.

Sincerely,

Richard E. Sanderson
Director
Office of Federal Activities

Enclosure

Detailed Comments
of the U.S. Environmental
Protection Agency on the
U.S. Nuclear Regulatory Commission's
Programmatic Environmental Impact Statement
related to the decontamination and disposal
of radioactive wastes resulting from
March 28, 1979, accident at Three Mile
Island Nuclear Station, Unit 2.
Draft Supplement Dealing with
Disposal of Accident-Generated Water

1. Page V, Paragraph 3 -- We suggest adding "and lesser amounts of other radionuclides" to the second sentence. A table (or tables) should also be added to Section 2 with complete analytic information for all 25 or so compartments where accident water is located. These tables should include results of all analyses done, with Minimum Detectable Amounts (MDA) provided when results are below detection limits.

The Summary here, the data in Table 2.2, and the initial case data taken from the licensee's (GPUN) proposal for disposal of the accident water seem to conflict with the original tank content data provided by GPUN and what is achievable by ion exchange. For example: if Cs-134 is present in concentrations only 2-10 times less than Cs-137 in the untreated water, it will not be totally removed from the treated water while Cs-137 remains.

2. Page xxi -- Add "U.S." preceding "Environmental Protection Agency."

3. Page 2.2, Paragraph 2 -- Is it appropriate to say "very slight traces" for Sr-90 when the achievable (i.e., after initial treatment) concentration exceeds Appendix B, Table 2 (10 CFR 20) limits by a factor of 33, and exceeds the base case by a factor of 367? In the base case, Cs-137 also exceeds the Maximum Permitted Concentration (MPC) in Appendix B, Table 2, of 10 CFR 20. We recognize that the table is correct and, that after final treatment, all standards will be met.

4. Page 2.3, Table 2.2 -- We recommend noting that the base case represents retreatment of 40% of the water as it currently exists and the "achievable" represents 100% retreatment.

5. Page 2.5 -- What is the source of the quoted background levels of Cs-137 and Sr-90? For example, EPA's latest Environmental Radiation Ambient Monitoring System (ERAMS) data published for Oct-Dec 1985 and Jan-Mar 1986 indicate a range of 1-3 pCi/l Sr-90 in milk. A review of data for Region III indicates that concentrations have reached or exceeded 5 pCi/l only two quarters since January, 1975, and have not exceeded 3 pCi/l since September, 1982. Yet, the document lists 5 pCi/l as the background level for Sr-90.

6. Page 2.7, paragraph 2 -- This paragraph suggests that the only time that analysis was done for tritium in the Susquehanna River was in 1977. In fact, daily to quarterly sampling and analysis for tritium and other isotopes are done at 17 locations on the Susquehanna by Pennsylvania or EPA (either TMI or ERAMS) and other locations by several utilities including GPUN. The MDAs for these determinations are all of the order of 200-300 pCi/l, however, and the results are below these levels. These routine programs should be mentioned to avoid giving the impression that no sampling has been done since 1977.

7. Page 2.10 -- Is this 1963 report the latest and definitive data on boron? We recommend that NRC consider more recent references.

8. Page 2.13, para. 4 -- To assure consistency of presentation, we recommend extending the drinking water limit discussion to include all isotopes actually present in tanks.

9. Page 2.14, Table 2.5 -- (1) While we do not believe the results would be affected, we recommend NRC extend the presentation to include all isotopes present in tanks, including a comparison of MDAs to Maximum Permissible Concentration for Water (MPC_w) (10 CFR 20, App. B, Table II) and Drinking Water Limits for isotopes found to be below MDA. (2) The MPC_w for tritium (App. B, Table II) is $3x10^{-3}$uCi/ml, not $3x10^{-5}$ uCi/ml. The drinking water limit is $2x10^{-5}$ uCi/ml.

10. Page 2.15 -- The State of Pennsylvania is in the process of becoming an Agreement State. If this occurs, it could have an effect on the disposal options for the waste.

11. Page 3.1 -- We recommend the use of BEIR 1980 as a reference rather than BEIR 1972.

12. Page 3.2, Table 3.1 (Note b) -- Unless demonstrated to be absent, other isotopes should be mentioned if present in the original tanks.

13. Page 3.14, para. 3.2 -- To clarify this alternative, the standards in 49 CFR 173 for bulk shipment of liquids should be explicitly compared with the nuclide concentrations in the water.

14. Page 3.15, Section 3.2.1.1, para. 3 -- Has in situ vitrification been successfuly tested for quantities of waste this large? Intuitively, it seems the electrical demands would be very high.

15. Page 3.16 -- The assumptions for nuclide concentrations for accident analysis should be explicitly stated. Both the base case and achievable case given in this supplement represent the average case of 2.1 million gallons of water which is actually in 25 separate compartments or tanks with concentrations as much as 2-3 orders of magnitude different from the base case. There does not appear to be any simple way to achieve one uniform batch of water.

16. Page 3.20, para. 3.3 -- Has the risk of transporting cement to the site been considered in the accident predictions for the options involving solidification of water or evaporator bottoms?

17. Page 3.23, Table 3.9 -- The predicted concentrations of Cs-137 in the finished cured concrete are not different from the average concentration in soil in this area. This would not add to gamma exposure since it would, in effect, become part of an infinite slab source.

18. Page 4.9 -- Routine determinations of gross alpha and beta activity, as well as radium, etc., are done by Pennsylvania at many locations and should be mentioned.

19. Page 4.9, Sec. 4.1.3, para. 1 -- What are the units for the water table gradient? Offsite well monitoring conducted by GPUN and EPA should also be mentioned.

20. Page 4.12 -- The description of the vicinity given here should be clarified. TMI is in the extreme NW corner of the area described. Interstate Route 95 and State Route 10 have minimal importance to the area while routes not mentioned (Interstate Rtes. 81, 283, and Rtes. 11, 15, 322, 422) are important.

21. Page 4.13, Fig. 4.7 -- The figure shows TMI to be in the Northeast part of PA instead of the South Central, and does not show routes from TMI to Interstate Rte. 80.

22. Page 5.1, Sec 5.1, para. 2 -- The level of 87 mrem is probably somewhat lower than real per capita background exposure. From the Aerial Radiation Monitoring System overflight data, ambient external gamma radiation ranges from 70-120 mrem/yr. Also, many houses in the TMI area have elevated radon levels, resulting in lung doses much higher than the external gamma levels.

23. Page 5.2, Table 5.1 -- The impact of the Short-Term River Discharge is the same as that of Long-Term River Discharge only if the same river flow is used. If a more reasonable higher flow is used, impacts are much lower.

24. Page 5.3, para. 1 -- We recommend adding "at 87 mrem/yr." before "300,000 people will receive...".

25. Page 5.4, Sec. 5.2, para. 2 -- EPA policy is to use BEIR 1980 values and the relative risk model for calculating risks which, as noted, will yield slightly higher risk estimates.

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26. Page 5.8, Sec. 5.4, para. 2 -- The accident scenario described here would appear to be impossible rather than highly improbable since the water is in 25 separate tanks/compartments.

27. Page 5.9, Table 5.2 -- See comment for page 3.2 - Cement transportation.

28. Page 6.1, Section 6.0, Conclusions -- EPA concurs with the NRC Staff's conclusion that no significant environmental impact from a radiological standpoint will be incurred from any of the proposed alternatives.

29. Appendix B is so generally written that persons without a technical background cannot understand how the calculations were made. Many references, including the applicable NRC regulatory guides, are not mentioned. It is not clear how the pathways to man were calculated, what bioconcentration, accumulation, and transfer factors were used, what fish/shellfish species were considered and how food web elements were incorporated into the model. Major clarification or explanation is needed.

30. Page B.1 -- Where do the data for swimming come from? There appears to be very little swimming in the Susquehanna River in the TMI area.

31. Page B.2 -- What is the basis for the shellfish harvest and consumption figures? No references are given.

32. Page B.3 -- What is the basis for 434 lb./yr. vegetable consumption? This sounds high, especially if this is supposed to be local consumption of locally grown vegetables.

33. Page B.4 -- What is the basis for doubling inhalation dose to account for ingestion of contaminated vegetables? This sounds very conservative for Nevada where precipitation, fog, etc., are relatively rare and gardens would have to be irrigated.

34. General. For the sake of clarity it would be instructive to include a section or appendix explaining what estimates of 0.03 or 0.4 or 1.5 cancer deaths really mean in terms of likelihood of having 0, 1, 2, 3, 4 cases or deaths.

PENNSYLVANIA
DER

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
Post Office Box 2063
Harrisburg, Pennsylvania 17120

Deputy Secretary for
Environmental Protection

May 1, 1987

Dr. Michael Masnik
TMI Project Directorate
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Gentlemen:

We are offering comments on NUREG-0683, the Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979 accident, Three Mile Island Nuclear Station, Unit 2.

We have considered the ten alternatives discussed in the report. Based on our review, we recommend against the two alternatives involving direct discharge to the Susquehanna River. This recommendation is based on our concern for the public health and safety of the people in the region and their utilization of the Susquehanna River. Regarding the other eight alternatives, we are making no recommendations. The difference in the potential impacts among these alternatives is small.

Sincerely,

Mark M. McClellan
Deputy Secretary

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Statement of Dr. Ernest J. Sternglass

My name is Ernest J Sternglass, Professor Emeritus of Radiological Physics, University of Pittsburgh, Scool of Medicine, where I have taught courses and carried out research in the area of radiological instrumentation and the health effects of low-level radiation since 1967 Prior to this, I held a position as Advisory Physicist to the Director of the Westinghouse Research Laboratories, where my functions included the development of Nuclear Medicine Instrumentation, X-ray imaging systems, nuclear radiation detectors and the development of advanced concepts for gas-cooled nuclear reactors In the course of my professional activities, I have been elected to membership in various scientific and professional organizations, including the American Physical Society, the Radiological Society of North-America, and the American Association of Physicists in Medicine I have published books, review articles and scientific papers dealing with both radilogical instrumentation and the health effects of radiation

I have examined the Environmental Impact Statement related to the decontamination and disposal of radioactive wastes reulting from the March 28, 1979 accident at the Three Mile Island Nuclear Station, Unit 2 (NUREG-0683, December 1986) as well as related documents and letters furnished to me by the Susquehanna Valley Alliance As explained in detail in the testimony which I gave before the Citizen's Advisory Board at its March 25th, 1987 meeting, the official trancript of which is made part of the present statement, it is my professional opinion that the proposed open-cycle forced evaporation of the 2 1 million gallons of the accident-generated water containg strontium-90 and other biologically very hazardous isotopes would present a significant risk to the lives and the health of the public, and that alternative methods of handling the problem exist which would greatly reduce this risk at comparable or lower direct costs

In particular, based on an examination of the mortality statistics for Pennsylvania, Maryland, New York and other nearby states following the previous venting of the Three Mile Island containment building between June 28 and July 11 1980, together with the measurements of strontium-90 released by Harvey, Piccioni and Pisello (1) who found that a comparable amount of strontium-90 was discharged into the atmosphere as is proposed in the planned evaporation option, I estimate that between 100 and 400 excess infant deaths and a comparable number of deaths of adults at all ages, will result from the proposed release
The basis of my conclusions may be summarized as follows

1) According to the Environmental Impact Statement (EIS)(NUREG-0683, Suplement No 2 Draft Report) Table 2 2 page 2 3, 0 9 Curies or 0 9 trillion picocuries are present in the 2 1

Draft Report) Table 2 2 page 2 3, 0 9 Curies or 0 9 trillion picocuries are present in the 2 1 million gallons of water waiting to be evaporated, or at a concentration of 110,000 picocuries per liter (One picocurie is one millionth of one millionth or one trillionth of one Curie, and one liter is slightly more than one quart) For obtain some feeling for the magnitude of this amount of strontium-90 still in the remaining waste water, it should be noted that the bottom of Range II of the Federal Radiation Council Guidelines for the consumption of milk issued during the period of nuclear testing in 1960-61 where concern was warranted and steps to reduce the intake should be considered was only 20 picocuries per liter, and the recently introduced maximum permissible level for drinking water by the EPA is only 9 picocuries per liter The maximum value measured during the height of nuclear testing was 31 picocuries per liter of milk according to the EIS (NUREG-0683), page 2 9 Thus, the present amount in the stored water would contaminate 100 billion liters of milk to the level of picocuries per liter deemed of public health concern by the EPA, or 30 billion liters to the highest level recorded by the U S Public Health Service during the height of nuclear bomb testing

2) Using the dose factor for infants ingesting food or water containing strontium-90 as given by the Nuclear Regulatory Commission in its publication NUREG-1 109, namely 0 0185 millirads per picocurie, this represents a dose commitment of 16 65 billion millirads to the bone of infants This means doses of 16 65 millirads to a billion infants, 16,650 millirads to a million infants, or 165,500 millirads to one hundred thousand infants if the strontium-90 in the water were to reach their milk, food and drinking water, regardless of whether the releases are spread out over days, months or years

3) The EIS assumes that only 1% of the strontium-90 will actually escape into the air with the evaporated water, or 9 billion picocuries This must be compared with the 50,800 picocuries reported by the NRC in NUREG-0218 as having been released to the atmosphere during normal operation of TMI Unit I in 1975, some 177,000 times less But even assuming that only 1% will escape, the above doses would still be very large Thus, enough would escape to give a dose of 1,650 millirads to one hundred thousand infants if the amount escaping would enter their diet or the air they breathe Even assuming still further that only 1% of the amount escaping actually enters the body (1), this would still represent 16 5 millirads for 100,000 infants But extensive studies by Stewart (2) and others (3) (4) involving diagnostic X-rays during pregnancy have shown that the developing infant is some 100 to 1000 times more sensitive to the development of leukemia and other childhood cancers than the adult depending on the stage of

development. More recently, a large scale study by Kneale and Stewart on the effect of measured background radiation in England involving 22,351 early cancer deaths (0-15 yrs) has shown that only 160 millirads per year, or 40 millirads during the most sensitive first three months of intrauterine development, double the risk of leukemia and cancer (5). Thus, one would expect that 16.5 millirads would result in a 40% inrease in childhood leukemias and cancers alone in a group of 100,000 infants born in the years after the release. Since about 1 in 1000 infants normally develop leukemia or cancer, among 100,000 infants, 100 cases would normally be expected. Thus a 40% increase represents 40 excess cancer and leukemia deaths as a result of the proposed method of evaporating the waste water, or 2.5% per millirad. If one were to assume that only the portion deposited on farmland enters the food chain, as did Harvey et al (1), the estimate would be cut to 16 deaths. However, since other long lived isotopes also contained in the waste water have not been considered at all in the above rough estimate, and since the maximum bone dose estimate arrived at in the ESI of 3 millirads is of the same order of magnitude as the 6.6 millirads estimated above assuming only the material deposited on farmland reaches the infant, it is clear that at least of the order of 10 to 40 cancer and leukemia deaths may be expected as a result of the proposed release. This is some 10,000 times more than the 0.003 cancer deaths estimated in the ESI (Section 5.2) based on data for adults exposed to short external radiation doses such as occurred at Hiroshima or in the course of medical diagnosis. But, as explained in detail in my oral testimony of February 25, 1987, these adult populations exposed to short external exposures are not appropriate bases for comparison with infants or fetuses whose DNA repair processes are not yet developed. Furthermore, long chronic exposures by beta rays to crucial organs of the developing immune system such as the bone-marrow, for which the damage is mainly produced by the much more efficient production of free-radical oxygen (6)(7)(8), are some 1000 times more damaging to cell-membranes than short, high-dose and high dose-rate exposures. The much greater mutagenic effect of low dose irradiation than expected on the basis of earlier high dose studies has recently been demonstrated in laboratory studies on single human chromosomes incorporated in hybrid cells (9).

4) However, cancer and leukemia are not the only serious health consequences of the ingestion of strontium-90 and other internal beta-ray emitting isotopes. In the case of bone-seeking isotopes such as strontium-90, it is the cells of the immune system developing in the bone-marrow that are the most critical targets. Studies not considered by the NRC staff or the BEIR Committee on whom the staff relies (Section 5.2) indicate that at doses in the range of

millirads projected for the proposed release, clearly detectable damage to the cells of the bone-marrow has in fact been detected by Stokke et al (10) as discussed in my oral testimony. Still more recently, laboratory studies by Heller and Wigzell (11) have shown that strontium-90 preferentially deactivates the so-called Natural Killer (NK) cells, one of the most crucial components of the natural immune defense system of the human body against viruses, bacteria and cancer cells. As a result, strontium-90 not only increases the risk of developing leukemia and cancer, but also increases the risk of dying of infections, thereby affecting total mortality due to all causes and not just cancer mortality as assumed in the NRC staff's estimates of deaths, helping to explain the gross underestimation of the health risk arrived at in the ESI.

5) Aside from strontium-90, there are a series of other important radioactive chemicals which are contained in the waste water to be evaporated into the air around Three Mile Island such as cesium-137, tritium, carbon-14 and iodine-129. Among the most serious of these is iodine-129 listed in a letter (Document ID 0068P dated February 18, 1987) submitted by GPU to the NRC but not even mentioned in the ESI (NUREG-0683). Just like iodine-131, this element seeks out the thyroid gland of the developing infant, where it concentrates as much as 100 times as strongly as in the muchlarger thyroid of the adult (12), except that per picocurie it is much more damaging in its long-term effect because it has a half-life of some 16 million years, as compared to only 8 days for iodine-131, staying in the body much longer and being recycled in the environment generation after generation.

Whereas the NRC staff only considers the relatively small risk of thyroid cancer resulting 10-20 years after exposure, the most critical health effect actually is the reduction in output of thyroid hormone controlling the physical and mental development of the fetus and the infant during the first two years after birth. Even a small reduction in the rate of development of the lung can lead to inability to breathe immediately after birth, causing infants to die of respiratory distress within a few days after birth in much greater numbers than due to all cancers and leukemias combined.

As discused in my March 25th testimony and the article on the Chernobyl accident attached to the present statement (13), it is the underdevelopment of the newborn which rose sharply in the U.S. during the period of fallout from nuclear weapons testing (14) and which appears to be the single most important factor leading to the slowing down in the normal decline of infant mortality. This decline resumed only after the end of large-scale atmospheric weapons testing, but it reached the low rates projected by the pre-war trend only in areas like Wyoming and

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New Hampshire where there were no large nuclear plants or other sources of fresh fission products in or near their borders, as predicted by the hypothesis that radioactive iodine and strontium radioisotopes were the pricipal new causal factors in the environment. Since there are about 10 times as many infant deaths due to all causes combined as due to leukemia and cancer, one must therefore expect that some 100 to 400 infants will die as a result of the proposed release. These deaths do not includecomparable number of deaths due to weakened immune systems among older adults and those in future generations due to the long-lived strontium-90, carbon-14 and iodine-129 in the diet for centuries to come, none of which was considered in the ESI.

6) These estimates are supported by the actual increases in infant mortality in Pennsylvania, Maryland,and Upstate New York outside of New York City as published in the U.S. monthly vital statistics following the earlier venting of June-July 1980 at Three Mile Island in which a comparable amount of strontium-90 was discharged. Thus, comparing the six months of July through December after the venting with the first six month of the same year, one finds the following increases in infant deaths:

For Pennsylvania: a rise of 115 from 1032 to1147, an increase of 11.1%
For Maryland: a rise of 99 from 288 to 385, an increase of 34.4%
For Upstate N.Y.: a rise of 29 from735 to764, an increase of 3.9%

For the three areas combined, this is an excess of 241 infant deaths, or of the order expected from the 2.5% increase per millirad for the early infant in the first trimester found by Kneale and Stewart for childhood leukemia and cancer in relation to background radiation in England, Scotland and Wales. In contrast to the above increases, the U.S. infant mortality as a whole kept declining at an average rate of 0.4% per month during this period.

The causal connection of this rise in infant deaths with the radioactivity released in the the venting is further supported by the fact that for the month of July 1980, the number of births in Pennsylvania suddenly rose by 41.4% from 11,358 to a record high for 1980-82 of 16,065, followed by a sharp decline to12,499 in August, indicating that some 4,700 births took place prematurely immediately after the release. Such early delivery leads to a sharp increase in underdeloped and underweight babies, which is known to be the biggest single cause of infant death in the United States today, a rise that began in the early 1950's (14) when nuclear weapons testing began A second wave of premature births occurred in October, followed by the largest number of infant deaths in 1980, namely 218 in November, for a record rate of 17 1 deaths per 1000 live births, compared with only 12 5 for the U S as a whole that month

7) The connection with the relese of radioactivity from the venting is further indicated by the fact that when the radioactivity in the environment began to decline following the end of the July 1980 venting, infant mortality for Pennsylvania suddenly dropped at the highest rate ever seen in the entire history of Pennsylvania vital statistics, namely a decline of 36 3% in the two years following July 1980 The number of infant deaths in each six month period and the successive declines as reported in the monthly bulletins of the U S Vital Statistics is as follows

July-Dec 1980	1147	0	0%
Jan -June 1981	990	-157	-13 7%
July-Dec 1981	846	-144	-14 5%
Jan -July 1982	781	- 65	-7 7%
July-Dec 1982	731	-50	-6 4%

This sudden decline in infant deaths when all radioactive releases from Three Mile Island Units 1 and 2 ceased is perhaps the most significant supporting evidence that the large radioactive releases from these facilities were responsible for the previous rise The situation is exactly paralell to the case of the cholera epidemic in London in the early 1800's, when the epidemic ended after a public water pump suspected of being contaminated was closed down

This conclusion is especially difficult to avoid when one examines the decline in infant mortality after 1980 in various states at different distances from Three Mile Island , as shown below by a comparison of the changes between 1980 and 1981 in Pennsylvania, Maryland, New York, and Vermont

State	1980	1981	Change in No	Change in %
Pennsylvania	2179	1835	-343	-15 7%
Maryland	675	594	-81	- 12 0%
New York	3210	3062	-148	-5 6%
Vermont	63	59	-4	-6 0%

Although these declines in infant mortality in Pennsylvania after 1980 probably reflect not only the end of the venting but also the continuing decline of environmental radioactivity produced by the original accident in 1979, the rise in the second half of 1980 relative to the first half cannot be explained as an effect of the March 1979 accident

Although infant mortality is not the only health impact of the venting since especially the immune systems of older adults are also weakened by the chronic radiation of the bone-marrow produced by strontium-90 and other radioisotopes, it produces the most immediate effects and can therefore be used as an early indicator of serious public health impact of radiation releases into the environment

Furthermore, present NRC dose calculations must now be regarded as grossly underestimating the population dose. They assume that airborne releases do not enter distant drinking-water supplies even though run-off from agricultural land into rivers is recognized as an important source of drinking water contamination by herbicides and pesticides. Also, they only consider the population within an arbitrary 50 mile zone to be affected. However, as both the above data and the recent experience following the Chernobyl accident indicates, the radioactive gases can contaminate the air, the drinking water and the food supplies far beyond this 50 mile limit. Furthermore, food and milk affected by airborne contamination within a 50 mile radius is often shipped to nearby large metropolitan areas, as is the case for the Philadelphia, Baltimore and Washigton Metropolitan areas within 75 miles of Three Mile Island, so that the existing computer models greatly underestimate the true population size affected by airborne releases

In conclusion, there is by now sufficient laboratory and human epidemiological evidence of unexpectedly large health effects of chronic exposures to low levels of radiation especially for the developing infant as compared with all theoretical expectations based on the earlier findings for adults exposed at very high dose-rates, that the option of releasing large quantities of strontium-90 and other internal emitters into the air or drinking water can no longer be regarded as accetable

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April 13, 1987

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Comments Received at the January 21, 1987 TMI Advisory Panel Meeting

ERIC EPSTEIN: In that this is a very sensitive subject, I think that the panel should not rigidly enforce time constraints on questions and presentations by the community. And in addition, I think you have already addressed this, I hope the water disposal issue does not become a secondary item after this meeting.

I do appreciate the fact that GPU responded to my questions concerning post defueling monitor storage; however, I am not satisfied with a number of the responses, especially the ones dealing with decommissioning. And rather than pursue a line of questioning tonight, I will defer to the next meeting if that is okay with you, Mayor.

[Discussion]

I am submitting a list of questions, about 22, to the NRC concerning their revised Environmental Impact Statement. I request that they be made a part of the official record. And rather than distribute them to you right now, I think it would just distract from my presentation, I will give it to you later.

Tonight I am speaking on behalf of Three Mile Island Alert, which is a nonprofit safe energy group based in Harrisburg.

Both the NRC and GPU have stated that the quantities of radiation released during the disposal of the contaminated water would be insignificant. But we must realize that they always say this. We don't believe that any radiation dose is safe, especially in this area where radiation has been vented steadily for the last 14 years.

I don't remember a time when the utility admitted that significant levels of radiation have been released, including the 43,000 curies of krypton-85 vented on central Pennsylvania for 13 days in July of 1980.

We have serious reservations about the disposal options sanctioned by the NRC. In fact, disposal is an incorrect term. There will be no actual disposal and no guarantee of containment. Instead, radioactive materials and industrial chemicals will be dispersed in the environment.

We do, however, have certain objectives we would like to see met. Our prime and overriding concern is minimizing radiation exposure to the local population and the environment. For example, we would like to see 100 percent of the water filtered and processed within a closed cycle.

We also think that workers' exposure should be minimized since many of them have been human sponges for the last seven and a half years.

Dose rates to populations outside of central Pennsylvania should also be minimized.

In addition, cost and time should not be factors. GPU should spend as much money and take as much time as needed to find the safest method of disposal.

Considering these objectives, alternatives such as dumping the water into the Susquehanna River and on-site evaporation are clearly unacceptable due to the potential harmful physical and psychological threat that they present to the community.

We do request the following steps be taken before a final decision is made: A meteorological study of the area surrounding TMI; a study examining the psychological stress that would result from the planned disposal methods; an inventory of all the radioactive elements and chemicals that are in the water; and a review of the GPU's current proposal and the NRC's revised EIS by an independent agency not affiliated with the nuclear industry of the Government.

At this time I would like to remind the panel of some of the past behavior of this utility and the NRC, because this is a crucial factor in understanding the built-in distrust and fear of area residents.

We remember that in July of 1980, 43,000 curies of radioactive krypton-85 and other radioactive gases were vented from Unit 2, even though TMI 2 was designed to release approximately 770 curies of krypton-85 a year. The venting occurred a little over a year after the accident amidst widespread fear and concern. Later in November, the U.S. Court of Appeals for the District of Columbia ruled in Sholly versus the NRC that the krypton venting was illegal.

We remember that in the spring of 1983 three senior-level engineers charged that GPU and Bechtel deliberately circumvented safety procedures and then harassed them for reporting safety violations. The NRC fined GPU and Bechtel $64,000 for intimidating and harassing Larry Parks.

And, of course, we remember the reactor head lift between July 24 and 27, 1983, which was delayed due to brake failure on the polar crane. GPU vented radioactive gases into the environment despite pledges by the NRC and GPU that no venting would take place during that head lift operation. GPU was later fined $40,000 by the NRC for the brake problem.

We remember that on June 1, 1984, the NRC released transcripts of closed NRC Commission meetings. The transcripts revealed a commitment on the part of the Commission majority to restart TMI 1 as soon as legally and politically possible.

Also evident was a significant disdain for public views on the restart issue and a serious lack of understanding of the legal and technical issues. This is the same agency who will ultimately decide how the water will be disposed.

We remember that between February 10 and 12, 1985, the Philadelphia Inquirer reported records at TMI demonstrated that in hundreds of cases, workers had been contaminated by radioactive materials either on the skin or through ingestion. The result was that workers were living in a state of anxiety, fearing cancer, birth defects, and possible genetic damage for future generation.

We also remember the health suits, the spills, the fines, the leaks, the miscalibrations, the exposures, the criminal convictions, and the one-celled organisms.

So when the NRC and GPU say venting, dumping, or burying 2.1 million gallons of radioactive water will have a negligible impact on our health and environment, people just don't believe them. Why should they?

People live with a fear that they and future generations have suffered serious health effects as a result of the accident and GPU's mismanagement. This fear has fostered a great deal of psychological stress in our community. Stress can be translated into long-term health effects, and they are very difficult to measure. Yet it is one factor that the NRC will not identify in measuring health risks from the disposal of the water.

Let me conclude by saying that we are not scientists and we do not feel that the burden of producing a safe and expedited method of disposal should fall on the shoulders of the community. The decision on what to do with this water should not be made in haste and should not be made until all possible alternatives are explored and exhausted.

People in this area have been dumped on enough. I think we are just tired of being the guinea pigs. That concludes my official statement.

GORDON ROBINSON: What agency, independent agency, would TMI Alert recommend?

ERIC EPSTEIN: I don't know what agency. It maybe doesn't have to be an agency, but people that aren't tied to the industry or the Government would be helpful to us.

Of course, whoever we recommend, I am sure the utility and the NRC would resist as being bias or subjective, but that is the same kind of bias we feel with the NRC and perhaps the utility have done.

GORDON ROBINSON: Have about EPA?

ERIC EPSTEIN: EPA again is a government agency. And, you know, Bill is a nice guy and all that good stuff, but EPA if you look at the way they have handled chemical issues throughout the country, it has not been real good.

So if you would like, I can get a list of folks; and if you would like to forward them to the NRC, I would be happy to do that.

GORDON ROBINSON: I would like not a list of folks, but hopefully some group or agency or something that -- yes, I would like a list.

ERIC EPSTEIN: Perhaps "folks" is not the best terminology. But I can produce that if that would help you.

KENNETH MILLER: In your opening statement dealing with the water, you mentioned the fact that you would like to see the water filtered through a closed-loop system.

ERIC EPSTEIN: Right.

KENNETH MILLER: What do you have in mind there?

ERIC EPSTEIN: I don't know what I have in mind there. But one of my questions here is that they had to make an adjustment to the filtering system that is usually not closed; and I was wondering, if they had to make an adjustment to open it, why they couldn't keep it closed? And that is one of the questions I had submitted to the NRC.

Here it is, Question 5, "Why not let the transportable evaporator operate in the closed cycle?" And I asked, "How accurate has the volume reduction figure been in other plants?"

Rather than go into that, it deals with the specifics of the EIS. I don't see why it has to be open and vented. That is my main question. What are you having a problem understanding?

KENNETH MILLER: I don't see how you accomplish anything with what you are proposing. Basically you are just running it through a closed system and accomplishing nothing.

ERIC EPSTEIN: What I am asking is that it be processed and cleansed as much as possible. I notice on proposals that 50 percent of the water is -- why not 100 percent of it processed and gleaned for as much chemical elements as possible?
What not go the extra yard? is all I am saying.

ARTHUR MORRIS: Are you suggesting further filtration of sorts; because if you are talking about a closed evaporation system, the idea really is to reduce the volume. And if you are not going to reduce through evaporation, then the volume stays the same.

ERIC EPSTEIN: I mentioned evaporation is unacceptable to our group, so I think they should probably deal with that.

ARTHUR MORRIS: So you are talking about further filtration?

ERIC EPSTEIN: And processing. You still look befuddled, Ken.

KENNETH MILLER: I guess I just don't understand what the end point would be that you have in mind by doing this.

ERIC EPSTEIN: Well, I don't think there is an end point.

KENNETH MILLER: If you are not going to evaporate the water, there is no point in further filtration.

ERIC EPSTEIN: I am not going to sit here and take other people's time bantering back and forth with you.
[Discussion]
All I need for the next meeting is a written list of individuals and agencies for you?

GORDON ROBINSON: Yes, if you would.

ARTHUR MORRIS: The next person who asked for time is Frances Skolnick.

FRANCES SKOLNICK: Frances Skolnick.
I am speaking for the Susquehanna Valley Alliance, a safe energy organization formed in 1979 to prevent the disposal of the accident-generated water into the Susquehanna River, our drinking water source.
The SVA established as one of its goals the safe disposal of this radioactive water. And we are as committed as ever to achieve that goal.
I am speaking here this evening to raise major concerns with this panel about the disposal of the water, with the hope that its members will seriously study and evaluate these concerns and find suitable answers and explanations.

I believe that it is important to clarify certain points about this radioactive water, estimated to be about 2.1 million gallons. But who knows at this time whether or not it might amount to 3 million or even 4 million gallons when end-point is reached, an event whose definition has not yet been clarified.

All of this water is not sitting in tanks on-site just waiting for disposal. It is stored in various locations, including the reactor core system covering the damaged and melted fuel and in the reactor building sump, the area where presently only robots may go because it is so highly contaminated. Therefore, a large quantity of this water about which we speak is still in contact with highly radioactive elements.

Furthermore, it is my understanding that this accident-generated water is to be used for flushing and washing out the system after defueling. Defueling is a hazardous procedure which continues to meet with obstacles and time delays, including the growth of micro-organisms and the inability to get the chunks of material broken up.

Which brings me to our concern about the presently listed contents of this water. To list tritium, strontium, cesium, boron and sodium only serves to simply the matter and insults yours and my intelligence.

Unit 2 ran for a matter of months before it expired, and not at all gracefully. According to Dr. Carl Johnson, M.D., M.P.H., as many as 500 radioisotopes are formed during the fission process. Fifty-two of these transuranics are formed. Some of these transuranics are less toxic; however, some are highly toxic to man, including plutonium. Another transuranic, nepunium-239, after a short life becomes plutonium. When plutonium and similar radionuclides enter the tissues and the body of man, they become a permanent resident in the body and continue to emit alpha radiation. The excretion rate is very slow; about one-half would be excreted every 200 years.

In animals plutonium causes cancer of the lung, bone, kidney, mammary gland, lymph nodes, nesothelium and ten types of soft-tissue cancer.

Transuranics are soluble in water. Indeed, they were found in the water in Denver, which is downwind of Rocky Flats and also in Broomfield, close to Rocky Flats. Excess cancer incidence has been reported in those areas.

It seems crucial to us then that this water is tested independently and with sophisticated alpha radiation monitoring equipment, starting right away, and continuing for the duration of the cleanup.

We demand a table of contents of the water, which would include a list of the transuranics. Telling us that a radioisotope is below detectable limits is not enough. We need assurance that the correct equipment is being used to detect transuranics, and what the lowest detectable limit is for that machine for each radioisotope. Then and only then can we evaluate the health impact of any of these methods of disposal.

Dr. Carl Johnson also advised me about the alpha recoil effect which causes particulate matter to pass through filters. Dr. Johnson would be more than pleased to come before this panel and explain the whole matter of transuranics.

What we also need and want to evaluate is an inventory of the core prior to the accident, the amounts which have left the area and their content; then we can estimate the radioisotopic content of what is left.

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Other elements not listed in the table of contents, and which must be listed in order to make an evaluation of the disposal methods, should include the chemicals used in the decontamination solutions and the oils and greases which were clearly alluded to in the Environmental Impact Statement of 1981.

We do not want to be told they are below detectable limits. We want to know quantities and concentrations used to date and projected quantities and concentrations up to the end-point.

It is also imperative that we know how this water would be processed prior to disposal, since concerns have been raised in the Environmental Impact Statement of '81 about chemically-laden water clothing the Epicore and the SDS systems and causing them to work ineffectively.

What we are suggesting, therefore, is that it is premature to consider the disposal of a liquid whose contents are not yet clarified and could change.

We believe that it is unwise to give GPU Nuclear the freedom to dispose of this water by a certain method when, perhaps in six months or year, we could discover that the Epicore or the SDS is no longer adequate for treating this water, and the method selected for disposal would no longer prove adequate and safe.

I have addressed the tritium content of the water and its possible health consequences in my last statement to this panel. It is not the innocent radionuclide which the NRC and GPU would make us believe. It is more likely to have been deemed innocent because of the unavailability of technology to remove it from water.

Tritium is the unstable element of hydrogen and has a half-life of 12 years, which means it is will be toxic for 120 years.

Experiments with tritium have concluded that tritium does have negative effects upon organisms. These experiments include those by Dobson and Cooper, who concluded that there is no threshold below which reproduction in mice is not adversely affected. Zamenoff and Martens observed that mice who were continually fed low doses of tritium suffered brain damage. Experiments conducted by Mewissen and Ugarte to determine the cumulative genetic effects from exposure of male mice to tritium for ten generations led to a reduction in the off-spring and a rise in infant mortality.

Since the preferred chemical state of tritium is water, it has free access to our bodies and other living organisms. It can enter into our bodies in three ways: (1) inhalation, (2) ingestion, and (3) absorption through the skin.

It readily enters into our food chain through plants and animals who are subjected to the same contaminated environment. We are not only talking about the people, plants, and animals of central Pennsylvania, but also those of the Chesapeake Bay and Baltimore area.

Our conclusions about tritium and its adverse health effects lead us to press for greater efforts to isolate this radionuclide from our environment. It just isn't good enough or acceptable that thousands of curies of this radionuclide is allowed to contaminate our water and our air.

I wish to draw your attention to a document. It is NUREG CR 39773 prepared for the Division of Waste Management Office of Nuclear Material Safety and Safeguard, the Nuclear Regulatory Commission, by Brookhaven National Laboratory, Department of Nuclear Energy, which discusses

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alternative containers for low-level wastes containing large amounts of tritium.

The availability of these recommended containers whose life span is up to 250 years would give us an option of maintaining that water on-site in a safer manner than at present.

The impact of the disposal of this water on our health cannot be seen outside of the context of all previous, present, and future releases of radiation into our environment, from not only TMI but all the other nuclear plants and industries releasing radioactivity.

An overwhelming amount of data have been accumulated that show there is no safe level of exposure. And there is no dose of radiation so low that the risk of developing a malignancy is zero.

It is evident also that all persons do not run the same risk of developing a malignancy from a given radiation exposure; and that the risk of some types of cancer is greater for some people than for others.

The data presented by the NRC concerning risk of exposure to the population by any disposal method is both controversial and not acceptable to us.

There was, indeed, an air of flippancy in the NRC document considering disposal methods. Two of these methods should never have even been considered at all since they are not available: Those include the dumping into the ocean, which is banned by international treaty; and the other is the use of Maxey Flats, which as a low-level waste site has been closed because of leakage.

When the Nuclear Regulatory Commission discusses dilution as a possible means of reducing population exposure to radiation, many reputable scientists scorn that idea.

In a conversation with Dr. Richard Piccioni, senior staff scientist for Ascord Research of New York, he said, and I quote "On the basis of the linear model of cancer risk and radioactive exposure, it follows that it doesn't help to dilute the radioactivity into the environment. It only allows them," meaning the NRC and GPU, "to get below certain legalistic limits."

We were deeply horrified and insulted when Dr. Travers at a recent Harrisburg meeting informed us that this water was not pure enough for the nuclear power plant's pipes, however, it is being considered to be put into our environment.

It is evident that this document and the future disposal of the water needs close scrutiny by independent scientists. I believe this panel must convene before meeting with the Nuclear Regulatory Commission to do exactly this.

If any method is given approval at this time, we feel that we are giving GPU Nuclear license to further disregard any problems which will undoubtedly arise with this water.

We do not trust GPU Nuclear with preserving the integrity of our environment. Their track record validates our position.

Our message to you and the NRC is clear and simple. There must be independent review of this document, not only by way of letter to the NRC but through this panel and in the form of a public meeting. This organization has independent scientists willing to come forward.

We will on no account tolerate this water being disposed of into the water or the air. We need further research and discussion on the method to keep the radioactivity from entering our environment.

We intend to use all our resources to achieve the goal of this organization, which is to see the safe, and I repeat safe, disposal of this radioactive waste.

BETTY TOMPKINS: Betty Tompkins.

I am Betty Tompkins and I live there. You are lucky I lost half my notes.

If I was convinced that health and safety issues were primary, both with the NRC and GPU Nuclear, I could have attended my Sunday school class teacher's meeting this evening; however, it is not my policy to deal with convicted criminals or to believe them.

I am not a physicist; but more importantly, I am a citizen of the United States of America which guarantees me the right to the pursuit of happiness. For the last eight years, this has been -- my right to such has been denied and it continues to be denied.

As I listen here this evening, I couldn't help but be reminded of a court of law where sometimes truth and justice is desolved by how good the two lawyers are. And we heard -- a lot of preparation has gone into it by staff people, by paid people. We are just volunteers, but we have done our homework. I concur with the last two speakers.

One of the things that really gets to me, and it says right here, is that the TMI 2 license currently prohibits disposal of the accident-generated water and will require amendment before any disposal maybe performed.

I think the whole -- this is premature. There is a lot of homework that they have to do and they have not done it. There is a lot of things that they have to concur with. DOE must give its approval. The TMI license does require amending.

I cannot understand why a damaged reactor even has a license. That is a real puzzle to me. I just don't understand that. If a person is sick, they are given a power of attorney because they are considered to be incompetent to manage their affairs. But a nuclear reactor can still operate on its same old license. It puzzles me.

There are lots of things that have to be done. The amount of strontium-90 and cesium-137 to be released during evaporation, the amounts are undetermined and will depend, it says in here, on the design of the evaporator and how many times they lift the lid, however that does happen.

The time for public input on this has been 45 days. It is not enough.

I really tried to do my homework. I got this about two weeks ago through the mail. I have read halfway through it and made comments. And for us to -- the public just to have 45 days to comment is not enough. There is a need for public meetings to comment on this and for the public to have adequate input.

The Pacific Northwest Institute and the Department of Energy seem to be together. There is no -- I don't see any independent surveyor work done here. The tritium concentration in the Susquehanna River was measured ten years ago. There needs to be an update on that. It says that right in there, "ten years ago." It probably has changed.

It says it will be monitored. We have come to realize -- the releases -- whatever system they go with, they say the release of radioactivity into the air, the water, or anywhere will be monitored. It has been our experience that monitoring is a very loose term unless we sit on them night and day to see that they are monitoring it properly, and have the proper things to do it with.

I think I said that about the small amount of the cesium and all that other stuff that goes into the air.

I don't have very much to say today. I am not a physicist. I said that at the beginning. I am a citizen here. I have studied this for eight years. I don't think that it is my responsibility to come up with an adequate way to dispose of this water.

In my innocence, I would say let it sit on-site and decay naturally. I have heard the young lady back here, I think she is probably a scientist, say they didn't really come up with any one way that was preferable over any other way. I think that needs to be considered.

I also believe, I really believe that there ought to be some real concern about the health and safety of the persons downstream. We can't all live upstream. And I don't think that has really been given a lot of consideration.

We met with DOE one time. I know people who tied up into a lot of this technology, and health and safety doesn't seem to be a primary concern. It needs to be. We live here.

And to expedite for the sake -- and I know it has been answered, but not to my satisfaction, that in the expedition of the removal of the water, dollars have not counted into it. I believe it has.

So I would ask this panel (1) to ask for an independent study; and (2), to give some direction to GPU. Not to let -- sometimes it is the tail wagging the dog. And we need to be telling them how we would like it cleaned up and what we would like them to do with our environment, not just listening to them and letting them floor us with all the technology.

I believe, I think I said that I had an eight-year course and failed it. I would believe if all the panel was given a test on what was said tonight by the experts, I believe that you might get a C or something because it is difficult to follow along with what they are saying.

So take that into consideration. Ask for an independent study, public hearings, and send them back to the drawing board.

[Discussion]

DICK BROWN: My name is Dick Brown. I live in Lititz. I am a science teacher. I have been involved in the environmental movement probably for 20 years.

Several years ago I spoke to the NRC representing the Lancaster Environmental Action Federation on our position opposing the restart of Unit 1. I am speaking as a citizen tonight. I am not representing any entity except myself and my own experience.

One of the things that I found in the NRC's presentation that disturbed me was the calling of the tritium, radioactive nuclide. What we are really talking about is radioactive water. The stuff that we are talking about releasing is radioactive water. It is not a little big name thing sitting around just giving off different kinds of radiation. It is a

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water molecule that just happens to have a hydrogen in it that is radioactive. It is H_2O.

H_2O makes up 70 percent of our body and covers 72 percent or 71 percent of the earths surface. It is found in every living thing on this planet. And, yes, there is some tritium water in nature. It has been there for probably billions of years. But in the concentrations we are talking about, it doesn't exist that way.

The problem I have with this release is that the tritium water that would be released or evaporated from this waste would be allowed to enter all of our environments. It would act as all water does. This water would form as dew on the leaves. It would become snow. It would become rain. It would be part of the water of plants as they absorbed it after the rain into the roots. It would become part of their system. Every animal that eats that plant would then absorbed that tritium water into their bodies.

All of us would eat plants raised in the most productive nonirrigated county in the United States. We would be part of the system. That tritium would become part of the ecosystem of this country or other surrounding areas.

It would not go out into the ocean or somewhere else. It would end up, a lot of it would end up here, as the water that is already here. And my concern is that it shouldn't be introduced into this system.

What should be done, in my opinion, is taking the first alternative, which I think is probably in some respects good; and that is to separate the tritium water and the other water that is not tritium contaminated from the other radioactive materials.

That water should not be evaporated into the air but should be distilled. You know what a still is. We simply take the water and recollect it by cooling it. Then we have just the tritium water minus as much of the crap as we can get out of it.

Then we find a way to take that tritium water and put it somewhere else, but not in Lancaster County. And I think that is what has to be done. I don't believe it should be released in any way, shape, or form in this county, stream, air, or anything else. And it should be taken off site, as should the other waste as well.

ALAN BRUNS: I am Alan Bruns. I live in Lancaster and teach at Franklin and Marshall, teach physics.

I want to second the concern of one of the people who spoke of the transuranic elements. Now, that may have been dealt with in another report; but I didn't see it at all in this report, and I have not read on this reports.

They are produced in large quantity. They were produced in large quantity while the reactor was acting. And all that has been exposed to the water that we are contemplating discharging.

To give you some figures that will indicate the severity of this, I refer to a book -- well, I can't seem to find it. I must have left it at my seat back there, but I have the figures.

It is a book written by four authors who are from the Energy Institute in Palo Alto, so it is a substantive book. It speaks of the dangers in reprocessing materials, which isn't being done now, but in a sense we are

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dealing with materials in a state which normally would be reprocessed. The most dangerous is cesium-137. But only 10 percent as dangerous is americium-241, which is produced in a quite a large amount. And curium-244, which is one-tenth as dangerous as the cesium.

Now, the study or the report seems to indicate considerable attention to the cesium problem, but I see no mention of americium or curium. Plutonium has a danger which is lower than that.

Another way to indicate to you the significance of small amounts of these transuranic elements is to give you, out of that same reference again, figures on the concentrations that are allowed for materials.

Plutonium-239 if discharged into the water is allowed to have a concentration of .1 pCi/l above natural background. Now, I don't know whether that is in the direct discharge or after it rumbles around in the river a little bit and mixes up above the dam or not.

That converts to .0001 pCi/ml, which is one one-hundred thousandth of the achievable strontium-90 after retreatment. So we are dealing with figures which are extremely small for these alpha remitting transuranics compared to cesium, strontium, and tritium, which the report addresses.

Again, to give you a feeling for how tenuous that concentration is, you get 10^{-4} pCi/ml if there is but 1 atom in 10^{16} plutonium. If it is discharged into the air, that same table in that reference which I can supply, it says that you can have a level of 2×10^{-9} pCi/l of air. That is unbelievably small.

I don't know what that converts to in terms of concentration, but it is certainly infinitesimally below parts per million.

So I just want to give you those figures as a way of trying to impress upon you that what this other person said, who is not a scientist whatsoever, I think has behind it some concerns that bear out the request to get definitive statements on what is the concentration of the transuranic elements that we are dealing with.

AL MANIX: I am Al Manix. What I want to state here is I did some research and I was quite concerned.

I would like to help the good people in Lancaster County and Dauphin County get rid of this junk. I went to Manly-Regan Chemical Company. I was concerned. They were shipping chemicals in and out almost every day. They are a pretty busy outfit. They are not real big, but they are busy. I stated to them that I had a problem; that if we shipped this material out by railroad tank cars, how would it go. They said one tank car carries 10,476 gallons of water. So may be we need 200 tanks cars, and everybody in Dauphin County and Lancaster County would be real happy.

In case anybody wants that again, I will give it to you, or you can call up any chemical company and they will tell you what size tank cars they are using and what sizes are available, or you can call the railroad people for that matter.

Thank you.

BEVERLY DAVIS: My name is Beverly Davis.

First of all, I think one of the main problems that people have with this plan or any other plan is that we do not trust, as has been mentioned before, the inventory of what is actually in this water.

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When it has washed against the fuel in the reactor coolant system for some years here, it seems unbelievable that there are only seven elements that were not able to be filtered out of it. Just one resource that I read said 36 elements, and that wasn't even counting transuranics, would be manufactured in there, in the process of creating electricity.

Another thing that we do not trust is the fact that, even though we are given these as absolute figures, it appears that we have only monitored and have only filtered or tried to filter certain things. The SDS system has worked hard at getting cesium. The EPICOR worked hard at the strontium. Therefore, we seem to have good figures at cesium and strontium.

I am wondering if there are a lot of other things that we either do not have the technology for or simply have not been listed that should be included.

Another thing that we have a problem with is the sources of all the water. We keep hearing about outfall, and maybe that is only the water which comes from rain which is collected in potholes on the island. I am not really convinced that is the only kind of water that is coming out of the outfall.

The additional water which would be used at the end of the time process, which would be in the fuel canal, I am not sure whether that water is included in what we are talking about or not. That would seem to me to be highly contaminated water. The water which, I believe if I am not mistaken, is now over sludge in the basement in order to contain the radioactivity, is that water included in this inventory? We are not sure that all of it is being trapped by the filters, as I said before.

Going back and reading some of the earlier drafts and reading some of the earlier information, it appears that there were fines which are not filterable. One of the reasons that they were not able to be filtered is they clung to boron in the water; and they, therefore, were not separated by the normal natural processes that were being used.

I was also told at least twice here that transuranics were not soluble. Therefore, we didn't need to worry about those being steamed out of the water, yet I read that there are different kinds of transuranics.

I don't know which transuranics are contained within here, whether they are all actually nonsoluble or not; but I understand there are different kinds, some are more soluble than others. We have not received all of the scientific studies which might bear on the release of what has already been delivered to us from this plant.

For instance, the Public Health Fund has never released the study by R. Patrick, as far as I know. That was supposed to be giving us accurate information or up-to-date information, as I understood it, about what might have gone through the food chain or might have been in the sediment in the river.

What we have already gotten has got to be considered in this. And I think that that is one of the things that bothers people a lot, is that there has never been any kind of a definitive cumulative total given of what we have already acquired as a public from this plant.

We keep saying, Well, this is just a little bit more. We don't mind adding a little bit more of this and a little bit more of that. The public does not feel very secure about that because we feel that the cumulative dose adds up to a lot more than these minuscule doses that people keep talking about.

We don't trust GPU that they could deliver any kind of a release of anything. They have not been able to be trusted to do anything right up to this point. They always make mistakes. They always have technical difficulties. I don't think anybody in this public trusts them to do anything in terms of even the release of what you are saying is a very low level of radioactive water.

One of the things which is not included in the report which bothers me a lot is that there is no evaluation in the environmental section of the report on the fact that this is a closed-air basin. I don't know what the technical term is for it, but I know that a certain burning is prohibited. I know that we have many inversions.

I know that along the river we are subject to fog. I know that from reading some other things, that the aerosol effect of radionuclides being injected is maybe different in a biological sense than to simply receive them as particles or as air gases.

Mainly, I think the biggest thing is that people are concerned here that you have not evaluated the effect on people. And I don't mean in terms of taking a technical reading of what radionuclides they might absorb through this.

What we are talking about is public policy. And if I may give you a very crude simile on this. I have a septic tank in my backyard. And when it fills up after ten years or five years or whatever, I have someone come in and pump it out and take it away.

I can live with that septic tank full or empty in my backyard and with the possibility that it might leach. But I cannot live with the possibility that someone is going to take a bucket and dump it over the head of everybody in my family. I think that is the way the people in this area feel.

They feel that when the krypton was vented out, the public policy had not up to that time said -- they had said that there were caustics, there were chemicals, there were things that might leach, there were things that might accidentally escape. There could be all sorts of transportation accidents.

But for the first time in my knowledge, or in my experience, a whole public was told that we are going to give it to you. We are going to push it down your throat. We are going to give you toxic material, which we agree is toxic, which could be detrimental to your health. And we are going to give it to you because we want to get rid of it. We don't know what else to do with it, and we are going to give it to you, the public, and let you absorb the dose and then figure out the consequences.

I think that is despicable public policy. I think that is what is happening again. And I think that is what is bothering people, more than even knowing whether there is very much radioactivity in this water or not. It is the insult to the population that is being told we are going to dump some more junk on top of you.

We don't know what we have gotten already. We know that we have already been exposed to this at least once, this kind of public policy. We have another dose coming at us, and people are saying, Don't worry. It is fine. Nothing to worry about.

I believe that the public would react most favorably to leaving that water on-site in tanks where it is contained. It is not being dispersed. It is not being evaporated. It is not being put down the river. It is not being put in their drinking water. It is being contained.

I resent that in this report and also in the report that was given the other night, that there is an adjective of "merely." We would merely hold this on-site, as if there was nothing to be gained by holding this on-site.

As I read the half-lives of the elements which are listed by this report --

[Interruption]

One-half a minute.

The greatest half-life that I understand in the elements that are listed is 30.2 years.

Apparently the license allows at least for this to be stored through the half-life of the most dangerous or the most long-lasting element that is in here. There would seem to be a great deal of advantage to that.

If you have to come along and pump out the septic tank at that point, that is another problem that somebody maybe can take care of. But until that time, I am very happy to have it sitting there in stainless steel tanks.

The only difficulties that I would see with that is the danger of floods, the dangers of ice jams, which Jeff Minik evaluated and nobody else has evaluated in any of these things in terms of what is happening on the island. Those are the only problems.

There is one little thing in the report that says something about the vents in the tank allowing evaporation to occur from these tanks, even if they sat there. That bothers me a lot.

But there seems to be very little against it. This panel has two missions, as I see it; one of the missions is that a lot of you on here are scientists, very distinguished scientists with a background of solid scientific information. We depend on this panel to give us that third-party scientific background to educate us and to ask the hard questions of the people that come forward.

The other thing we depend on the panel for is to convey and to establish public policy. And I would hope that both of these things would be addressed by the panel.

DEBRA DAVENPORT: I am Debra Davenport, Concerned Mothers and Women.

I just wanted to briefly say that I am also definitely thinking that this should be retained on the site temporarily, for a period of years, perhaps, until some other sites can be determined or a way to transport that water out of there can be thought about; or it should be taken to Nevada, which is clearly cheaper than evaporating waste on-site.

And in reference to that, I do have one question. Why evaporate and what will this cost? What will it cost to run the heaters? And who will provide that energy? And what will that cost? Will it cost the consumers?

[Discussion]

So there is some possibility that the consumers would have to pay for that?

FRANK STANDERFER: The monies for the evaporation of the water are included in the current total estimate for the cleanup.

It would be covered within the $965 million which we have set as the cleanup costs. So they are budgeted.

DEBRA DAVENPORT: That's all I wanted to know.

ELIZABETH SHIVA: Elizabeth Shiva (phonetic). I live in Middletown three miles from TMI. I would like to speak on behalf of the Concerned Mother's and Women and my many neighbors who were not able to be here tonight.

First of all, we do not have any faith in GPU, their directors of the cleanup, and the same loss of faith in William Travers of the NRC. We do not believe their quoted figures of percentages of radioactive doses to be released during the venting over an excruciating two-and-a-half-year period.

How can they know the doses that will be relased when they don't even have an idea of the amount of molten waste or a way to remove it? We have much less faith in the so-called facts and figures spouted off to the press by Gordon Tomb and Lisa Robinson. They are wasting their breath and our time.

I would like to know if Gordon Tomb's and William Travers' families will live in Middletown or the surrounding areas during the two-and-a-half-year venting period?

How dare you do this to us. My God, do we have to live through this for another two and half years?

DORIS ROBB: I am Doris Robb.

The last time I addressed this group I had asked a question of you, Mayor Morris, about the monitoring system for the water in Lancaster. At that time you told me to contact Michael Friedman, whom I did, and ask him questions about the type of system that we do have in place. That was the system that we received in Lancaster following the suit that we had against GPU Nuclear after the accident at Three Mile Island.

He told me at that time he was not able to find out the name of the system, and that didn't really make any difference to me. I wasn't really concerned about that. But I did ask him what the system was equipped to monitor. And he said it is a gamma monitor.

I notice from the presentation tonight that tritium and strontium are both beta emitters, and that also strontium is a beta, as well as a gamma, emitter. And so I am very concerned that Lancaster County really doesn't know, or the City of Lancaster, doesn't know what may be coming from Three Mile Island in the way of beta emitters coming down the Susquehanna River.

[Discussion]

BRIAN RESH: I am Brian Resh.

First off, I would like to express my total disdain for the condescension shown the public by GPU and the NRC.

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And my very brief question concerns the $965 million projected cleanup cost, and exactly how much of that will be borne by the consumer, the rate payer or both?
I believe the spokesman from GPU has the answer to that.

ARTHUR MORRIS: Mr. Standerfer, could you respond to that?

FRANK STANDERFER: That portion -- that is the Thornburg Plan, and about $200 million is borne by the consumers in New Jersey and Pennsylvania.
[Discussion]

BETTY TOMPKINS: Betty Tompkins. I would like to speak about the water of the City of Lancaster. I will speak now for the locked-in poor citizens of Lancaster City who drink that water and cannot afford bottled water.
I have in the past contacted Mr. Friedman about the water, and I had a statement mailed. I am not technically thinking right now, but what Doris said is absolutely right.
The City of Lancaster is not presently monitoring for these elements that we feel might be coming down from Three Mile Island. And so I ask you, as mayor of Lancaster, to look into that.

ARTHUR MORRIS: The City of Lancaster has equipment at the plant site that does -- we do run tests on a daily basis. And in addition to that, I don't know if Bill Kirk is here and can speak to the fact that there are tests run separately from the city on the water at the plant that we receive.

BILL KIRK: Bill Kirk. There is no good way to monitor beta on-line. There is a sample taken. As I recall, every hour or two there is a slug put into a jug and we get that weekly and analyze that, including tritium and strontium.
There is a continuous sample taken from the discharge at Three Mile Island. That is monitored on a daily basis, analyzed on a daily basis for tritium and on a weekly basis for strontium. And we are monitoring it at the source.

NIEL WALD: Isn't there also a requirement of the EPA under the Federal Clean Drinking Water Act that the drinking water of any public purveyor of water to the public be monitored for all alpha, beta, and gamma radiation?

BILL KIRK: Right. The clean drinking water standard for tritium is 20,000 pCi/l, which is very much higher than anything we ever deal with here.

ARTHUR MORRIS: I think what needs to be remembered is the test we run is a daily test with information available right away.
The tests that are run why EPA take a longer period of time than that. And we don't get those results for several weeks following the tests. We have not had a test that has shown positive, however, since the beginning of the problem in 1979.

BILL KIRK: I think there was one sample in eight years that bearly exceeded the detectable limit. And that was 350 or 400 pCi/l several years ago for one day.
Another other than that, it was below the detection limits in the order of 200 or 240 pCi/l.

THOMAS GERUSKY: Of tritium?

BILL KIRK: Yes

ARTHUR MORRIS: Again, the understanding when we received the equipment was we would have equipment that we could use with our own plant personnel on a daily basis that would give us a very quick verifiable feeling of an immediate problem.
That is what we are doing. We have a backup with EPA, but it takes a longer period of time to get that information, but it is checked.

FRANCES SKOLNICK: Is that for all three types of radiation?

BILL KIRK: The analysis includes a gross alpha and gross beta analysis, and specifically a tritium, and an aliquot is analyzed for strontium.
Basically we take a piece of each daily sample for a week and analyze the weekly sample for strontium.

FRANCES SKOLNICK: It is my understanding from different scientists that it is extremely important to understand that alpha radiation can only be picked up by extremely sophisticated alpha monitors.
I think what we are typing to point out tonight is, Do you look for gamma radiation with one type of monitor? Do you look for beta radiation with another type? And do you look for alpha radiation with another type of monitor?

BILL KIRK: Certainly. That is the only way to do it.

FRANCES SKOLNICK: Can you write down the names of the kind of monitors?

BILL KIRK: I will be happy to talk with you. I can give you generic answers. If we get down to speicfic instrument types, then we have to get the particular instrument that is being used.
I don't normally carry mark and mods in my head.

FRANCES SKOLNICK: And I would like to find the number of times during the month that each particular radiation type is looked for.

BILL KIRK: If you would look in the Long-Term Monitoring Plan, which has been published, there is a schedule of all the analyses which we do in that plan.
As far as the results are concerned, we have published the result of our tritium and air analyses. We have not specifically published the results of most of our water analyses, because they have been negative. There hasn't been anything to publish.

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The State has published the gross alpha and gross beta and tritium readings from all of the samples in their yearly report, in their annual monitoring report. The alpha and beta and tritium numbers have been published to '85.

FRANCES SKOLNICK: When you said "nothing," do you mean zero or do you mean below the detection limits?

BILL KIRK: Below the detection limits. And we have given you the detection limits for the different types of analsyes, I believe in the monitoring plan. I know for gamma we have and for tritium.

ARTHUR MORRIS: Is it possible for you and Frances to talk about this either by telephone or after the meeting? Can you provide her with the information that she is requesting? Is that okay?

BILL KIRK: No problem.
[comments]

A SPEAKER: It is my understanding that at the end of '87 the EPA will be phasing out their monitoring; that that is the plan for concluding the cleanup.
My question is, if EPA will be leaving at the end of '87, who will be continuing to monitor, particularly if the waste water is dispersed in some way throughout the atmosphere or discharged in the river?

BILL KIRK: The long-term plan that we had proposed perhaps several months ago calls for some of these things to be taken over by the State of Pennsylvania, the Pennsylvania Department of Environmental Resources.
We had called for in that plan to find out certain types of monitoring when the fuel was canned up and ready to ship, and other types at the time it has been shipped.
I am sure you realize what happens in the Federal Government when budget time comes along. Everyone gets uncertain for another year. My guess on whether something that we have set forth as a plan this year will continue to be true two years from now is as good as yours.
I at one time would have sworn to it and other times I won't not swear to it. It depends on what state is of the budget process we are in. I have been wiped off the books five times in the last seven years, and we are still here.

A SPEAKER: So there is a possibility of future monitoring?

BILL KIRK: Beyond the shipping of the fuel, there are no plans for EPA to continue specifically monitoring here.
EPA does not have any legal mandate to monitor around operating reactors. Once that cleanup has been finished, our role here is done.

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FREDERICK RICE: Yes, Frank, in the evaporation process, am I correct in assuming that all the isotopes are removed during that process and fall into this solid?
[Discussion]

JOHN LEUTZELSCHWAB: On the list of isotopes there, do they, any of them, exceed MPC?
[Discussion]

THOMAS GERUSKY: On your carryover, can you go into more detail on what the carryover monitor does and how it does it?
[Discussion]
Then this really isn't a monitor as much as -- It's not a radiological monitor in the sense we think of it in nuclear power plants. You're monitoring just the total solids, I guess, in the water, in the water vapor.

CHARLES URLAND: Yes.

THOMAS GERUSKY: The next step is you're doing radiological monitoring behind that, it looks like. What are you going to be looking for?
[Discussion]
They have -- Is there any automatic control that will shut the facility down if a preset point is reached?
[Discussion]
What are you going to do the liquid -- the radioactivity analysis of the release? Are you going to take the samples from the two monitors or are you going to just take them in the evaporator itself?
[Discussion]
On your strontium 90 decontamination factor through the exchange system, you didn't really -- The strontium 90 concentrations vary considerably, and you came out with one number. It really didn't show what the decontamination factor was. Do you have that number?

FRANK STANDERFER: Let Ken --

KENNETH HOFSTETTER: Decontamination number, of course, does tend to vary with the concentration of input water. That is the effluent, quality of the effluent remains about the same. So, for instance, when we were processing water out of the reactor building basement which had high levels of radioactivity, the DFs, if you want to call them that, were quite high. When we look at water which has been recycled, that is, has been reused for decontamination, picked up small amounts of water, the DF will appropriately be lower because the influent concentrations are lower as a result. For the reactor building basement where we had cesium concentrations of 120 microcuries per milliliter, DF to the total system was on the order of eight orders of magnitude. For processing the reactor coolant system presently, for instance, the DF is more on the order of four orders of magnitude because the concentrations of the influent are reduced accordingly.

THOMAS GERUSKY: Is that because of solubility, or shouldn't the decontamination factor remain constant no matter what you start out with, or is it -- I mean, particulate, I can see it being removable. What about the soluble fraction?
[Discussion]
I don't have any more.

ARTHUR MORRIS: Anybody else on the panel?

FREDERICK RICE: Frank, what is the time process of this mechanical process? Once it starts, is it continuous?
[Discussion]

JOEL ROTH: I'd like to backtrack to the automatic shutdown that Tom talked about and you talked about, Frank. Would you go into that in a little more detail? In other words, the scenario if something happens.
[Discussion]
What are the chances of that happening?
[Discussion]
How quickly?

FRANK STANDERFER: It's done in minutes.

JOEL ROTH: Now, how do you know then what has gone up or out at that point?

FRANK STANDERFER: You have taken samples. You can analyze those samples.

JOEL ROTH: But I'd like to backtrack again for more specificity to say what happens. Two minutes, something has gotten out that shouldn't have gotten out.
[Discussion]
Just one followup on that. If it does occur, is there a certain procedure that would be followed? In other words, I guess I'm trying to find out --
[Discussion]
Would that be made known to the public then?
Venting today, every day, right?

FRANK STANDERFER: Yes.

JOEL ROTH: So you'd have to look for it.
[Discussion]
Is that the new term, upsets?
[Discussion]

ARTHUR MORRIS: John?

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JOHN LUETZELSCHWAB: The output of the stack, the 100 feet, what is going to happen to that in the various conditions of weather? Is it going to touch ground? Is that going to stay above?
[Discussion]
So you assume this stuff released under your dose calculations?
[Discussion]
What minimum height would you need? I look at the coal plant down the river, and I see that nice coal, and it stays nice and high and just leaves the area. That's the whole purpose of it. What minimum height would you need to get it so that people in this area won't have to breathe any effluent from that and send it someplace else?
[Discussion]
But it doesn't touch ground within 20 miles or anything like that.
[Discussion]

THOMAS GERUSKY: Just a followup on that. Are you considering the possibility of putting it out the plant stack?
[Discussion]
Since you brought up the vendor issue, are your specifications for the evaporator, do they vary with, in effect, decontamination factor or removal concentration, removal factors or the particulates?
[Discussion]
That's the question I had. We're getting at it. Are you going to purchase the one that has the best reduction or what is -- How are you going to pick the vendor?
[Discussion]
Are they all the same ball park for cost?
[Discussion]

KENNETH MILLER: I guess I don't understand. Now you're talking about tremendous differences in volumes of solid collected. And I would assumes if you're not collecting them, they are ending up going out in the environment in steam. What makes a big difference of about a factor of four or so there?
[Discussion]

FREDERICK RICE: Frank, have you had to develop a special monitoring system to adapt to this evaporation process?
[Discussion]

JOEL ROTH: Just a followup question on what John had asked about weather conditions. Are there any weather conditions that would prevent the evaporation process from continuing?
[Discussion]
So, in other words, you're saying there are no weather conditions that would stop it, is what you're saying?
[Discussion]
It just wouldn't be the evaporation process?
[Discussion]

KENNETH MILLER: I have a two-part question. First of all, I assume that the NRC has done their own independent evaluation. I'm curious as to what sort of results they got and how they compare with yours for the environmental impact. Secondly, I'm wondering what sort of errors are associated with the assumptions that have to be made to get this type of number.

[Discussion]

Are there any glaring discrepancies between their results and yours?

[Discussion]

THOMAS GERUSKY: There is a difference between changing conclusions and changing outside dose. Is that what you meant to say, that the outside dose --

[Discussion]

Your conclusions are that any of the systems --

[Discussion]

GORDON ROBINSON: Is there anything unique about this evaporator, or is it one that has been used in other applications?

[Discussion]

So basically my concern was each vendor has had previous experience?

[Discussion]

ANNE TRUNK: I'd like to know how often you are going to do the monitoring and who is going to do it. Is it GPU or the vendor?

[Discussion]

Is there going to be somebody checking it all the time, or do you just every hour or so check it?

[Discussion]

THOMAS GERUSKY: Are you planning on changing your environmental monitoring program at all?

[Discussion]

FRANCES SKOLNICK: My name is Frances Skolnick. Mr. Standerfer, I would like to know why the SVA didn't receive a letter which you sent to the NRC on February 3 and 18, because we do have a legal agreement that we receive all written correspondence between the NRC and GPU concerning the water disposal.

[Discussion]

I did not receive one. I would like a copy, please.

[Discussion]

I would like you to be aware, please, in the future, because it is imperative that we receive correspondence immediately.

[Discussion]

It is, because I looked into this matter before some months ago, before the issue was brought to the front again.

[Discussion]

I'd just like to make some clarification here. The water that is already purified, is that going to be used again in the cleanup or is that sitting on site waiting to be disposed of, in tanks?

[Discussion]
On the page where it says estimated average concentration of radio-nuclides, at some point are you going to monitor for each of these radio-nuclides or will you be continuing to be doing mathematical estimations?
[Discussion]
Will you be using alpha radiation monitors for the samples before they go into the evaporator?
[Discussion]
But will the radiochemical anaysis find all alpha-emitting particles?
[Discussion]
Do you have a number or something that we could receive which states the detectable limits?
[Discussion]
I think I have just one other question. It concerns the chemicals. I'm aware that probably the sodium borate is the largest quantity of chemical in the water. But do you have a list of the other chemicals of lesser quantities?
[Discussion]
Do you have a list of those chemicals that you look for and that have, in fact, been used in the reactor prior to the accident and since the accident and cleanup?
[Discussion]
Would the oils and greases be included in that? Would they be removed?
[Discussion]
I have just one other question. When water comes out of the SDS system and the epicor system, and has an equal amount of radionuclides been removed from each? In other words, when that water enters the tank from each of the other tanks, the epicor system and the SDS, are they exactly the same? Are we mixing lower level radioactive water with slightly higher level?
[Discussion]
Okay. Thank you very much.
[Discussion]

AL MANIX: Al Manix. On a given day like today with the system in operation and you are dispersing the water, how far will it travel?
[Discussion]
Do you have a feel for how far it will travel? I want to see whose doorsteps it's going to land on.
[Discussion]
Half a mile, a mile, ten miles, fifty miles?
[Discussion]
100 miles?
[Discussion]
You're telling me the system was used before. So apparently this shouldn't be no big problem then. On a day like today, give me a number. Don't give me a yes; give me a number.
[Discussion]
That's saying a lot.
[Discussion]

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DICK BROWN: Yes, I'm Dick Brown, vice president of Lancaster Environmental Action Federation. I'm here representing LEAF. This is LEAF's statement on the evaporation problem.

The Lancaster Environmental Action Federation, better known as LEAF, has taken the following position on the Nuclear Regulatory Commission's proposal for the disposal of Three Mile Island waste water:

1. We believe the evaporation of the radioactive tritium waste water over Lancaster County is totally unacceptable.
2. A Nuclear Regulatory Commission decision on this problem is premature since the final quantity of contaminated water and the exact nature of the contaminants are not known.
3. This problem does not demand an immediate solution. Therefore, we recommend a more thorough study of this complex issue.
4. Costs must not dictate the final solution for disposal of these materials.
5. All decisions relative to the disposal of the various components of the TMI waste water must respect the integrity of the existing ecosystem and do nothing to endanger it.

Thank you.

JOEL ROTH: Will you be putting a copy of that in the record? I'd just like to ask a couple questions, Mr. Brown, if I may. Could you just give a very brief description of your organization to get a better understanding of who you're representing, you know, the numbers and area?

DICK BROWN: LEAF is an organization that has existed since 1972. We have a membership of something over 100. We have been involved in a variety of issues, including TMI, nuclear power back before TMI, farmland preservation and solid waste. Our main claim to fame probably is that we run recycling centers, and we have been involved in assisting the county with recycling over the past four or five years in a rather large way.

JOEL ROTH: Thank you. That's all.

THOMAS GERUSKY: I have a question. Do you have an alternative proposal then other than what has been looked at?

DICK BROWN: To answer your question, we are in a non-profit group of citizens, no staff. Basically, like many non-profit groups, environmental groups, trying to sort out the environmental dilemma, which is what we're in here. We met last night and we discussed this very issue. And we had a problem coming up with a solution, as everybody else is. The problem here is the same problem we have pretty much universally when it comes to pollution, and that is that man has taken material, scattered it through the environment in many places, and through this process has concentrated them to make its products, whether it's glass bottles or plastic bottles or neckties or clothing or whatever it is that we have. Almost all these things were at one time scattered. The uranium on Three Mile Island is an example of it. The environment is probably safe, in quotes. It's scattered so far that its effects aren't as great, but when you put in all in one place, you have a problem.

So we discussed this very issue. What do you do with something when you get a concentrate? The probably ultimate answer for this particular problem is to dilute it. You can't destroy it because it's water. My own opinion and, I think, that of the board that met last night is that the water should be evaporated in a position where it would go over the ocean, not over a populated area if it's going to be evaporated. It shouldn't be evaporated over any land area. It should be evaporated so that it goes over the ocean, probably in a colder climate where the water, when the tritium water did hit the ocean in a colder climate, say up northeast or perhaps in some other area closer to the ocean, would have less impact on the living creatures in the ocean because of the cold. At least that's what our biologists tell us. So I don't know whether that answers your question, but that was our dilemma. We discussed it, and dilution unfortunately is the way we do a lot of solving problems of pollution. And we believe it will be better to dilute it in the ocean or over the ocean than to do it over Lancaster County. That we feel strongly about.

JOEL ROTH: Okay, thank you. Well, if there are no further questions -- Oh, there is.

FRANK DAVIS: I'm Frank Davis, Mechanicsburg. I guess in answer to the question that Mr. Gerusky asked about alternatives, I think we need to go back to the assumptions on which this whole discussion is taking place, the need, the feeling of the people in the area that the waste should be removed so that it would be safer for the people here and safer for the workers. Now, I think that many of us have come to the position after studying the Environmental Impact Statement drawn up on this that the safest thing for the foreseeable future for both the people who live in this area and for the workers is to leave the contaminated water in the tanks where it is now and let it decay, rather than to subject the public and many workers to a great deal more contamination by evaporating it, by moving it around, by burying it and so on. And with proper care, I think that both the public and workers would receive less contamination, less exposure, if the water were allowed to decay in its present condition.
[Discussion, Recess, and NRC presentation]

ARTHUR MORRIS: Bill, just looking -- And I was out of the room when this statement was read from LEAF, Lancaster Environmental Action Federation. Their second point, I think, says that a Nuclear Regulatory Commission decision on this problem is premature since the final quantity of contaminated water and the exact nature of the contaminants are not known. How would you react to that comment, if you would?
[Discussion]
How about on the -- You have answered two of those parts. The one is on the quantity of contaminated water. We've been given a presentation on that today that total volume of water is expected to be somewhere between 2 and 2.3 million, and the variants of the 300,000 gallons has to do, we're told by GPU, depends upon the additional water needed between now and October, 1988. Your reaction to how good of numbers you feel they are.

[Discussion]

JOEL ROTH: Bill, I'm just going to try to put something in -- I'm trying to understand the logic here. The initial premise for the disposal of the water now and always has been that the Island should not be a low waste storage site. Then to jump in my mind to the monitored storage aspect of the end point, you know, of cleanup, where they are going to be monitoring allegedly some low-level waste that is going to be allowed to remain on the Island, is that correct?

WILLIAM TRAVERS: That's the proposal.

JOEL ROTH: That's their proposal. Are you saying then that it might not be, in fact, true that there will not be allowed to be any low-level waste remaining on the Island?
[Discussion]
I guess the reason I'm questioning this is because it's always seemed to be the anchor of the NRC's stand that the water had to go and other things had to go. And yet I'm getting a sense from the public in a very strong way, probably the strongest in a number of years, and what I'm hearing here is the fact that the public is saying, well, they'd really rather have it stay, you know, in the tanks for the time being. And I'm wondering if you had to rate on, say, one to five the damage or the health effects or something of that nature of allowing that water to say versus allowing whatever low-level waste is allowed to stay, which, in your opinion, would be the lesser of the damage, potential damage, if you follow. I'm trying to compare with using your basic premise which we have heard for seven years, that low-level waste has to go.
[Discussion]
What I'm trying at this point in my mind to understand, since we're probably going to have to vote on this and try to come up with some type of an idea on what to do and, in my mind, try to convey to the public or to myself what I'm hearing, and it's just the logic of it, I think, at this point is escaping me in that the interim monitored storage or the monitored storage routine seems to be almost a given, that something is going to be there. That may be all right. You know, I realize I'm jumping a little bit into that. But I'm just trying to get a sense of why can it not stay for the time being.
[Discussion]
Yes. Just one further point, if I may. I looked at the clock, and we still have time.

ARTHUR MORRIS: We have plenty of time.

JOEL ROTH: Is the fact - and I'm trying to phrase it so that we can understand - is with the public -- I'm not saying that some of them are not even saying that yes, maybe environmentally, I think again it goes to the emotion and the psychology of it, of just not wishing to be, quote, as I've read in some of these statements, be dumped upon or evaporated upon. And I think over the years that the psychological or the emotional

impact has and should be evaluated. So in that context, I wonder if you have --
[Discussion]

ARTHUR MORRIS: That's part of the problem we're facing now, is it's that water, and I think I understand what you're saying, that it's always going to be categorized as that water from the accident, whether it's a day or ten years from now or twenty years from now. And I'd like to -- If you would choose the option, if the option would be chosen to store the water on the Island, my assumption is that it would not be done in the fashion or the exact specific tankages that it's stored in today, that it would have to be -- Maybe some of the processed water stored in tanks 1 and 2 would remain. But some of the other facilities that are there that contain the water, I'm assuming, maybe wrongly, that you would empty the water out of those locations, and you would have to build additional tankage. Or has that been looked at at all or is it your assumption that it would stay exactly where it is now?
[Discussion]
I had thought that one of the concerns they had some time ago was in the capacity of the tankage and that there may be a time when they may run into a capacity problem and need to build additional tanks.
[Discussion]
I'd like, Frank, to have somebody speak to it. I really automatically assumed that they would not want to leave it in some of the locations that it is presently in, and they wouldn't want to put it in a totally contained --
[Discussion]
I clearly understand that. I'm not, as I ask questions, proposing that. I'm trying to understand that option, that should it be taken, would require additional tankage.

FRANK STANDERFER: Yes.

ARTHUR MORRIS: You're saying you have how much capacity? 1.6 million?

FRANK STANDERFER: I believe it's about 1.5, but I don't have that good number.

ARTHUR MORRIS: I realize and I would indicate your numbers for the record were just estimates and just getting a sense of it. Is that 1.5 or 1.6 capacity usable for the future storage or is it something that if you would go five years down the line, you would think we would start having a problem with seals or some other things, that we better build?

FRANK STANDERFER: No. It would be usable for some indefinite period of time. The tanks are good quality tanks.

ARTHUR MORRIS: So then you would need about 700,000 gallons maybe of additional tankage. The tankage at that point that would be on the Island lifetime, I mean, you're looking at not a problem for ten, twenty, thirty years or something like that.

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[Discussion]

ARTHUR MORRIS: We have water storage tanks. I don't even know if that's comparable, but obviously they last for considerably ten to twenty years if properly maintained.
[Discussion]
Just again, I just want to -- I'm trying to get a feeling for how much more tankage. How long would that last before it would need to be replaced and then try to correlate that with the half-life of -- How much have you really gained by waiting that long in half-life?
[Discussion]
You're saying that if you wait that long a period of time, the potential is that you start running into tankage problems and you'll need some replacements? Is that what I hear?
[Discussion]

ELIZABETH MARSHALL: Yes. I was wondering if there was any possibility of the tanks themselves, and I mean over a long period of time, absorbing radioactivity and becoming radioactive.

WILLIAM TRAVERS: No. They are stainless steel tanks. They wouldn't absorb the radioactive material contained in the water.

ELIZABETH MARSHALL: They would not?
[Discussion]

ARTHUR MORRIS: Is that the same as would have to happen with the remaining section of the plant, that the radioactivity would have to then be totally removed?
[Discussion]

KAY PICKERINE: Kay Pickerine (phonetic). I have several questions directed maybe to the NRC and EPA. I have not heard from either organization comments on how this process would be monitored. I heard GPU talking about the option of probably or possibly considering the installation of tritium air monitors. That just raises in my mind all the questions about the license, what options does GPU have when they are asking for this change in their license. What are the regulations with regard to the involvement of the NRC and EPA? The community hasn't really had a chance to discuss that kind of interaction with regard to the on-site actual monitoring. Tonight I really understand for the first time the process that a vendor would come in, building the system and then be responsible for the actual working of the system. That was all fuzzy in my mind until I got here tonight and heard that discussion. That just raised all those fears and all that psychological problem of again another entity coming in, GPU overseeing another contractor on site, doing work. Does the NRC then oversee GPU, and what are the regulations with regard to on-site and off-site monitoring of -- and DER, too. I mean, we have three entities who in some way monitor on site and off site the radiation factors monitoring.
[Discussion]

ARTHUR MORRIS: The monitoring that will be done on the evaporation itself is part of the equipment to be provided by the contractor?
[Discussion]
Any action that is taken as a result of the monitoring system in terms of a problem I assume would be the action -- the action would be taken by the contractor who is under some kind of overview by the -- by GPU. Is that what you would envision? Or should we be asking Frank? I'm just trying to bring out a little bit more of the question that was raised on what is the sequence of events that would normally take place.
[Discussion]

DICK BROWN: Dick Brown from LEAF. I have a question and a concern relative to what we were just talking about. One factor that hasn't even been mentioned is that TMI-1 at some point in this scenario will have to be decommissioned. And there will also be waste water from that facility which will have to be disposed of in a similar manner because there's going to be within -- This is a process that's going to have to take place in the future. And if I'm following the scenario correctly, they aren't going to do anything with the water until after they are done with the cleanup, which is at least the end of next year, perhaps even 1988, or end of this year. Then it's going to take two and a half years to evaporate the water. We're already into 1990. When did TMI begin, unit one? What was the year it started, was licensed?

FRANK STANDERFER: 1974.

DICK BROWN: They operated for five years. Now it's operated almost another one. So its life span may be only twenty years, 25 years. So by the year 2000, we may be talking about additional problems which may be - I'm just suggesting - maybe the water problem has to be addressed in the light of -- at that point, what's going to happen to the water at TMI-1 as it goes through decommissioning process at some foreseeable point in the future.
[Discussion]

ARTHUR MORRIS: So the TMI-1 water, whatever would happen in the end, would probably be, unless it's something very unusual, would be probably discharged. Is that what you're going to end up saying?

WILLIAM TRAVERS: It is being discharged.

ARTHUR MORRIS: It is now, and any water that would end up at that site would probably --

WILLIAM TRAVERS: Unless some unusual circumstance arose.

KENNETH MILLER: I guess I'm addressing this comment or question to Mrs. Munson. Back I guess in 1981 when the first Draft Environmental Impact Statement came out, I took a look at the tritium numbers and did some quick calculations of average Susquehanna River flow. And I don't recall the exact numbers, but it seemed that the amount of radioactivity

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we're talking about in this water flows by TMI every 150 days or so. I would guess if we look at Lancaster County and if we look at Dauphin County, we would find the rainfalls bringing this amount of radioactivity down in these counties with every so many inches of rainfall and so on. And I think that type of information may be very useful in explaining what we're talking about here in terms of radioactivity concentrations and what that means when it's put out into the environment. What we're talking about here, I think, is comparable to what is there already.
[Discussion]

ARTHUR MORRIS: Do you have a way of summarizing that fairly quickly? It does talk about it, but is there anything special you want to indicate that it says?
[Discussion]

KENNETH MILLER: So we're really talking here about total levels of tritium that if we could condense it down into a small volume, we could put it in about 2,000 watches and give it to people walking out of the plant to wear forever. When they are through wearing them or they stop working, they could chuck them out in any landfill?
[Discussion; Dinner Recess]

ERIC EPSTEIN: For the record, Eric Epstein, spokesperson for TMI Alert.
I know for Gordon, the first thing I wanted to clarify with you, I said I would have some names from some folks better known as scientists or technical experts. After discussing it with some other environmentalists and other members of my group, I have decided not to do that for a number of reasons that I would like to explain. First of all, I didn't think the NRC would fund their research. Secondly, I am very wary about handing over names of organizations to anybody, Gordon. So what we have done, and Frances will speak to it later, we have submitted the EIS and talked with various experts throughout the country, and hopefully we will be able to produce either testimony or an expert at the next meeting, and I know that was one point that you had pursued with me. I wanted to give you my reasoning for not preparing a blanket list of individuals or organizations. I didn't feel comfortable with it when I talked it over with other folks. If that's okay with you, I will continue.

GORDON ROBINSON: Yes, that's your choice.

ERIC EPSTEIN: If has just been after thinking, my experience with the NRC over the last seven years had a great impact on that decision.
What I am going to do now, Mayor Morris, is turn the speaker over to Vera Stuchinski, who is going to make comment for us this evening. After everybody else speaks, I'd like to get on the agenda, if I could, to address some of the questions I had for the NRC. She is going to make the official comments for TMI here this evening. So at this time I would like to turn the mike over to her.
[Discussion]

VERA STUCHINSKI: My name is Vera Stuchinski. I am sorry Eric and I were not able to be here earlier in the day. I decided to give him a break, as chairperson, and make the presentation tonight.

I have TMIA's comments to the panel on the NRC's revised EIS on the disposal of the water, and I'd like to present this as a matter of public record.

I appreciate the Panel's concern about the insufficient information provided to the public in the NRC's revised Environmental Impact Statement, and your determination to gather additional information before meeting with the Commissioners. As a representative of the citizens' safe energy group, Three Mile Island Alert, I would like to bring to the Panel's attention, the need for further assessment of the health effects of tritium.

First, let me preface my remarks with the fact that on Friday, February 20, General Public Utilities issued a statement saying that the Department of Energy has granted the utility an additional 46,000 cubic feet of disposal space at a commercial low-level nuclear waste site. The allocation is needed to dispose of radioactive residue from a proposed evaporation process. The Harrisburg Patriot News noted that the approval is a "significant step" for the utility in their proposal to evaporate the 2.1 million gallons of contaminated water.

It appears that evaporation is leading as the method of choice of both the utility and the DOE. We have been assured that dispersal of 1020 curies of tritium over a two or three year period will be inconsequential since tritium is to be found in the environment from reactor fuel, weapons testing, manufacturing and natural occurrence. It is noted in the revised EIS, that the tritium concentration of the Susquehanna River was measured during 1977 and found to be fairly constant at 178 pCi/L. The NRC's data on tritium concentration in the Susquehanna River, though, is based on information that was collected ten years ago. We feel this is but another superficial and inadequate investigation by the NRC. We would like to know the current concentration of tritium in the Susquehanna. The EIS should be revised to include data in order to be accurate and accountable.

At the Advisory Panel meeting on January 21, 1987, TMI Alert and other individuals stressed to the Panel that we want no additional environmental releases of radiation from the cleanup. I cannot stress this point enough. We are concerned with the cumulative effects of years of radiation exposure.

On page 2.6 of the EIS, under the section entitled, "Interactions of Tritium with Biological Systems," the report states that when humans are exposed to tritium as tritiated water by inhalation, ingestion or skin adsorption, the majority of the isotope is eliminated from the body with about a 10-day biological half-life. A small fraction of the intake, usually less than a few percent, is eliminated with a biological half-life of about 30 days, and even a smaller fraction with a biological half-life of about 450 days.

According to this report, it sounds as though the tritium is almost immediately eliminated from the body. But in order to calculate the hazardous life of the substance, one must multiply by ten. Therefore, the majority of the isotope is eliminated from the body with about a

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100 day hazardous life. A small fraction of the intake is eliminated with a hazardous life of about 300 days, and a smaller fraction with a hazardous life of about 4,500 days, which is about 12-13 years.
We do not know the long-term health effects of tritium, nor does GPU or the NRC. More empty assurances of safe levels are not what we need. I would like to call your attention to the report released in October, 1986, by Congressman Edward J. Markey, who is Chairman of the House Subcommittee on Energy Conservation and Power. It is entitled, "American Guinea Pigs: Three Decades of Radiation Experiments on U.S. Citizens." It describes in detail, experiments conducted by the Manhattan Project and the Atomic Energy Commission, from the mid-40's to the early 70's as supplied by DOE documents, and it was to measure the effects of radiation on humans. Markey urged the DOE to make every practicable effort to identify the subjects and to examine their long-term health histories to determine long-term health effects.
According to the report, from 1950 to 1952, human subjects were exposed to tritium in several different experiments: exposure to tritiated water and water vapor, inhalation of tritium-saturated oxygen, and the ingestion of tritiated water. The objective of the experiments was to obtain information on the absorption and retention of tritium. But, following the experiments, the DOE reports no medical follow up of the subjects. Obviously, here is a population if studied, that could yield invaluable information on health effects of exposure to tritium. As usual, GPU and the NRC are willing to proceed before the necessary factors have all been collected.
Another major consideration that has been ignored, as usual, is the impact of stress on citizens living in the surrounding communities. The contaminated water has not yet been tested for transuranics. As of the last meeting, the information was very sketchy. We feel this is essential. We have heard no statements from the NRC, EPA or DER concerning additional monitoring of the actual procedure, as well as any emissions that would be released. With GPU's long track record of misconduct and disregard for health and safety, we regard the additional monitoring by government agencies to be necessary for public accountability.
I must emphasize that we do not trust the utility. GPU must not be given the go-ahead to evaporate the 2.1 million gallons of contaminated water before the facts are in. I must also re-emphasize to you our position that the decision on what to do with the water must not be made in haste. GPU would like to dispose of the water quickly, so that they can finish the cleanup. Isn't it rather ironically amusing that in order to clean up the waste, the utility would propose contaminating the environment? That's our official statement from TMI Alert.

ARTHUR MORRIS: Ken?

KENNETH MILLER: I want to say I don't agree with everything you have said, but I don't really want to go through it point by point. What I would like to ask you is: What is your alternative? What method of handling this material are you proposing?

VERA STUCHINSKI: I don't feel we can endorse any of the methods. Again, I feel we are being asked to make a decision when the study is not complete. I would go back in time several years ago when we talked about at the last meeting krypton venting. We found about two or three years after the krypton venting an expert, Micho Kaku, from Columbia University or New York University?

ERIC EPSTEIN: CCNY

VERA STUCHINSKI: Talked to us about that there are alternative methods for dealing with the krypton gas. For example, perhaps, there are alternative methods for dealing with the water. I feel that we are being pushed to rush into a let's finish it up, and I do not feel that everything has been covered, everything has been studied enough.

ERIC EPSTEIN: I know, Dr. Miller, that you do not agree with many of the points made. I mean that is nothing new to me. I would like to say a few things. I don't think anybody would really have a problem with the materials being shipped to Hanford, the reservation in Washington, or to the Nevada test site. To be quite honest with you, I think that is probably a resolution that would be acceptable to a lot of folks.
I'd like to say also I just met with the NRC for four hours on Tuesday discussing activities at Unit 1 and also met with the NRC previously for three hours at Unit 2. It is quite apparent that Unit 2 with its fuel pools is an ideal place for the waste of high level and low level from Unit 1 and also Oyster Creek. It is apparent to me that we are rushing through this process to make room, and there is nothing in the license currently at Three Mile Island to prevent Unit 2 from storing high level or low level waste on site with the waste pools, and that is the feeling I have. I'm quite sure that will be born out in the near future.
I see, Tom, you are shaking your head.

THOMAS GERUSKY: Not true.

ERIC EPSTEIN: This is true talking with both the NRC, Region 1.

THOMAS GERUSKY: I'm sorry. Their license has to authorize them to receive material from outside that plant. They are not authorized to do that.

ERIC EPSTEIN: Well, there seems to be some disagreement with the NRC whether waste from Oyster Creek could be shipped on, but there seems to be consensus that from TMI Unit 1 there would be no problem using Unit 2 as a storage facility.

THOMAS GERUSKY: Oh, sure there is. Right now they are separated completely. They can't be used, and it is their license amendment. Again you can't do that, I'm sorry.

ERIC EPSTEIN: I think there is a big difference of opinion on that issue. I don't know if I want to pursue it at the advisory panel, but I don't

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think folks at Region 1 agree with you at all. I would hope you are right.

THOMAS GERUSKY: Well, if Region 1 doesn't agree with me, they are not going to operate the plant. I mean let's face it, they can't do that.

ERIC EPSTEIN: I hope you are right.
I don't know if that speaks to your question, but I wanted to preface my comments with that statement.
[Discussion and Dinner Break]

FRANCES SKOLNICK: Good evening, members of the panel. First of all, I want to start off in a lighter note.

ARTHUR MORRIS: Frances Skolnick, I'm sorry.

FRANCES SKOLNICK: When I was eating dinner tonight, I did have a fortune cookie, and the note on the fortune cookie was: "Your hard work will pay off soon."
I speak this evening for the membership of the Susquehanna Valley Alliance, a safe energy organization whose membership is mostly based in Lancaster County. The reasons we are so concerned about this radioactive water is because we stand to be impacted upon if GPU Nuclear either dumps it into the Susquehanna, our drinking water source, or evaporates it into the air.
Since we live downstream from the plant and we will therefore get the full impact of fallout, I am speaking at this public meeting this evening in order to convey our message loud and clear. Our message is this: As a community, we intend to stand up for our rights to clean air and clean water, and we feel that GPU Nuclear and the NRC are violating these rights.
We are really pleased that this panel is carefully considering the options presented to them. We are entirely sickened by the Nuclear Regulatory Commission and GPU Nuclear making statements about the safety of this water.
They have yet to learn that we are thinking, rational individuals, aware of our rights and able to discern deception from truth. Who do they think they are, telling us that they have three million gallons of radioactive water, which we are going to have to either breathe in or drink? Sorry, gentlemen, we will not allow you to do this to us.
If I may refer to the statement made by the lady from the NRC about tritium in exit signs and watches, I have to say we are not drinking or breathing the exit signs or the watches.
The documents which come from the NRC or GPU are shrouded in double talk, misinformation and a general lack of regard for the public. Their attitude is the show must go on at all costs.
Since the accident at TMI and particularly since the restart decision of Unit 1, it has become more and more apparent that we no longer have a regulatory body or even the pretense of one, but rather we have a promoter of nuclear power in the form of the Nuclear Regulatory Commission.

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This past year or so, we have all become increasingly aware of the fact that nothing has been done to store in a safe manner the abundant radioactive waste that the nuclear industry is creating. All of us are victims of this travesty, and I am afraid it is exacting this lack of waste policy and the fact that GPU Nuclear wants to incur as little cost as possible that is making these gentlemen sweet talk us into breathing or drinking this radioactive water.

This radioactive water is really not our problem. GPU created it. Therefore, why are we being asked to carry it around in our bodies? It is as if we are being asked to be waste storage sites.

Tritiated water can be ingested in liquid form. It can also be inhaled or absorbed through the skin in the form of water vapor or steam, and pregnant females, tritium ingested by the mother can cross the placenta and be incorporated directly into the fetus. Like all radioactive substances, tritium can cause cancer, genetic mutations or developmental effects. No threshold or safe dose of tritium has been scientifically established for any of these effects.

By either dumping the water into the river or evaporation into the atmosphere, all the tritium will be released into the environment. We are extremely concerned of the exact nature of this water, and feel that the list of contents by GPU Nuclear and the NRC is inadequate for both radionuclides and chemicals. Even if the water contains only those items listed, the water still remains radioactive. To say it is almost pure is nonsense, and further threatens the credibility of the Nuclear Regulatory Commission and GPU Nuclear.

The tritium alone is a major source of concern. The radiological significance of tritium is not related to its inherent toxicity, it is a very low energy form of radiation, but to its easy incorporation into all parts of the body that contain water.

Dumping or evaporation are therefore not true methods of disposal, which implies that we are getting rid of it all. But, rather they are methods of dispersal, which means GPU Nuclear would be spreading the radioactivity in different directions.

On Page 3.3 of the updates in the environmental impact statement, the NRC states and I quote: "Although most vendor supplied transportable evaporator systems are designed to operate in a closed cycle mode, modifications would be made to the evaporator to allow it to operate in an open cycle mode that would permit a vapor to be discharged into the atmosphere."

I have to ask: Why modify the evaporator at all? Let it operate as it was built to operate and contain the radioactivity.

I also must comment on the NRC comments that discharge would be monitored to verify radioactive releases. I am concerned about who would read the monitors. Furthermore, I am convinced that some members of the NRC and GPU Nuclear equate monitoring with prevention of radioactive releases. It is important to clarify that what is being measured has already been released into our environment and the damage has been done.

We firmly believe that it is imperative to contain all radioactivity which is manmade. The question of how dangerous is radioactivity to our health is very much a debatable question, and as long as it is, let us all, whether we are pro or anti nuclear, act responsibly and with caution when determining releases into our environment.

We believe also that it is imperative that technology is made available to contain the radioactivity of this water. We believe it is available, but cost considerations cause the Nuclear Regulatory Commission and GPU Nuclear to disregard it. I believe the NRC and GPU Nuclear are pushing us into making -- to taking a position and making a choice between evaporation or dumping, when really we do have more choices open to us.

I firmly urge the members of this panel, the NRC and GPU Nuclear to reject evaporation and dumping and to consider only those options favorable to the health and environment of this community. I am hopeful this panel will give the public permission to bring in additional experts to speak to the panel and that tonight we can arrange a date for the meeting

[Discussion]

Could you also clarify for us exactly how the panel will make their decision and what kind of decision -- I mean the procedure for you making your decisions about the --

[Discussion]

JOYCE CORRADI: My name is Joyce Corradi, C-o-r-r-a-d-i. I am with Concerned Mothers and Women.

Because of scheduling, I could not get to the meeting until the last half hour, so I do not know what happened previously nor will I waste my time or yours, I will find out after this meeting.

The one thing that Concerned Mothers and Women are very concerned about and would like to reiterate is what other groups and other individuals have said, that it is very important that you look at all alternatives, that you are not pushed into doing something because it is a quick fix. We have lived with quick fixes too long and the repercussions of them will be on us for many years to come.

I do have another question that concerns me very much about TMI 2 and information that was in the paper today concerning radioactive material that left the island via truck, and in the paper, Mr. Toom [phonetic] was contacted, and I would like some information on that, as to what happened and why it left the island.

[Discussion]

What I would like to know is what they violated in doing this what are the NRC's procedures for the handling of this material?

[Discussion]

I'd like to know what the NRC thinks about the incident.

[Discussion]

ERNEST GUILL: My name is Ernest Guill. I don't know if this relates to what you are doing, but has there been any study concerning the number of cancer cases and cancer deaths around TMI? Does anyone know, since the accident and following?

[Discussion]

Is there any governmental, local governmental monitoring unit or any local government, could they monitor the radiation from this evaporation or from the dumping?

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ARTHUR MORRIS: There is a whole host of monitors that are in place now around the site.

ERNEST GUILL: Who are they run by, excuse me?
[Discussion]
I want to know who is monitoring the equipment?
[Discussion]
I had it answered earlier, but what I was wondering was: Is there any way an independent monitoring group could check the radiation that is being released, or as I said, the local governmental body from the city of Harrisburg --
[Discussion]
I think I was trying to address the level of stress that people talked about that people around the plant had, but if some group like GPU is doing it or the EPA, a lot of times the people wouldn't know who the people are involved doing the monitoring. If it is some local government agency, they will at least know who the person is that is doing the monitoring, perhaps feel safer. That's my opinion.

ARTHUR MORRIS: If you mean the local government agencies, there is none that I know of that are doing that or plan to do it, and you would have to take it to the individual government agencies that are adjacent to it.

ERNEST GUILL: Lancaster doesn't do it?

ARTHUR MORRIS: We are not doing it, that I know of, for tritium and the type of particles we are talking about coming out of TMI, no.
We will go to you second.

BEVERLY DAVIS: Beverly Davis.
I think it is obvious from everything that people are saying tonight and other times that the only reason this meeting is held and the only reason this study is done is because there is a feeling among people in this area that they want to be protected and they do not want to have the water treated as any -- would be treated from any ordinary plant. This means that frankly this is a political decision. It has very little to do with science or anything else.
The unusual thing about this is this is a decision, a political decision being based on the fact that the people are objecting to having this water given to them, yet the decision is being made, the answer to the problem is to disperse it to them so they breath it, take it in their bodies and have to live with it. I don't understand why you would solve that kind of political problem with that kind of political decision.
The main thing I think needs to be realized is this is not disposal. There is no such thing as disposal. All we do, we live in a closed system. We move it from one form to another or from one place to another. To move it from the place where it is where it is contained to people's bodies who have already been through the accident, who have already been contaminated by whatever we have been getting for the past eight years, does not make any sense, and I would hope that the people who are making the political decision would make it on keeping those

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things in mind and not feel that the scientific part of it is the main part. The main part of this is a political decision. It requires a political answer, and that is what is best for the people in this area. Oh, one more thing: Following up on what Joel said, to say this is being based on the fact that the NRC has made the decision not to put low level waste on this island is a very -- is facetious. They have already made the decision that they are not going to dismantle that plant and move it out of here. Whether they say they have or not, it is not going to be practical for them to do that, and I don't think that decision is going to be made down the line.

So worrying about what you are saying six milligrams of radioactivity for some water, and you are worrying about whether or not to change your decision to put radioactive waste on that island doesn't make any sense when in the larger sense you have already made the decision to have fuel rods on the island. For many, many years you have made the decision to have concrete which is contaminated, the steel which is contaminated. You have elements that are going to be radioactive for billions of years, as you are saying tonight. So it doesn't make sense to say that that is the only reason that that decision is being made, because the NRC has decided that that should not become a radioactive waste dump. We certainly concur, it shouldn't be, but that is not really the issue. We aren't even talking about that anymore, because that decision was already made.

ARTHUR MORRIS: Thank you.

DEBRA DAVENPORT: Debra Davenport for the Concerned Mothers and Women.

I also want to speak on the potentially hazardous waste dump that we might get on Three Mile Island. For the last several months, there have been in the weekly status reports for Unit 2 the on-going evaluation or an indication that there is an evaluation going on in a solid waste facility. There is already an interim waste facility. If we are not going to have one, then somebody had better apprise us otherwise.

I feel -- although I know I was informed when I called or asked about this, that there indeed was such a facility in progress, that it would be for waste for Unit 1 and from Unit 2. What I would like to ask at this point is that I be given a copy of the evaluation, then we can decide whether or not there is going to be a waste facility on that island.

[Discussion]

ARTHUR MORRIS: Please, Bill, if you would.

WILLIAM TRAVERS: I think what you are referring to is an evaluation we have on going relative to what is called the waste handling and packaging facility, which is a staging facility for the handling and packaging prior to shipment of radioactive waste associated with the cleanup, so it is not in any way, shape or form the storage or disposal of waste on the site that we are looking at and evaluating. Any evaluations that we have completed or will complete are publicly available and would be glad, more than happy to get you a copy.

DEBRA DAVENPORT: I would appreciate it. Are there any other evaluations for waste sites at this point?

WILLIAM TRAVERS: Waste sites?

DEBRA DAVENPORT: Well, waste storage facilities.

WILLIAM TRAVERS: Not that I'm aware of. If there are, we will get you those, too.

DEBRA DAVENPORT: Because, I would like to say this, should this come up: I as totally opposed to putting anything like that on an island in the river. This makes no sense, floods. We were fearful in the beginning in this area. I think many people were fearful that the island would become a waste site, which it has, but to add to that problem is very, very careless. I feel all it does is save money and it wastes the lives of citizens in the area.

The only other thing I wanted to say was that I am still opposed to river dumping, and I am still opposed to putting this into the air. It seems to me to make sense to take this out to Nevada.

ARTHUR MORRIS: How do you feel about leaving it on the island?

DEBRA DAVENPORT: I don't think that would be safe. I can't be sure what they would do with the water, and also in other words, an emergency might come up. It might have to be disposed of, or it might have to be used in another way, and there is no way you can store it indefinitely or possibly not even for 20 years.

[Discussion]

JOHN ADAMS: John Adams, Susquehanna Valley Alliance.

I was told at the last meeting, there was some discussion about a distillation process that would remove the tritium from the water. Is there anyone that could comment about that?

ARTHUR MORRIS: I am not aware of that type of technique, but I think we were told that really wasn't possible, but if there is somebody else that can comment, please do so.

The whole premise of evaporation and the problem with disposing of the water is taking the tritium out of the water. But, there is no process really to do that.

JOHN ADAMS: So distillation is not a viable process?

ARTHUR MORRIS: The answer to that is: It is not a viable process, that's right.

JOHN ADAMS: Another comment, I would like --

ARTHUR MORRIS: Just to complete, I think we would love for it to be a viable operation, but it is not.

JOHN ADAMS: Fine. I wasn't clear about that information.

Another comment that I would like to make is that throughout the history of the nuclear policies and development of technology, these acceptable levels of radioactive exposure to the environment into human beings has been changing and has been dropping, and I think it is evident in the fact that x-rays are no longer routine for pregnant mothers, as they once were. We no longer have the type of devices in shoe stores where you can look down and see the bones in your feet. These have all been determined unsafe, and I think we might want to project our thoughts perhaps to some time into the future when we could look back at what is considered acceptable now, which will not be or may very well not be acceptable then and to say that the amounts of tritium are insignificant or acceptable is not a wise choice or decision to make. I think that those in the panel should take that into consideration, that these acceptable levels do change, and generally, they change for a lower acceptable level and not a safe level at all. Those are my comments.

[Discussion]

RONALD DAVIS: My name is Ronald Davis. I live in Millersville.

Recently, I had an educational experience which I wish I hadn't had, but I watched my father die of cancer, and prior to that, this issue of cancer and exposure to radioactive waste had been kind of an intellectual issue to me. But, I saw a man with tumors in his brain, in his lungs, in his spine, undergoing epileptic seizures, spending the last weeks of his life in intense pain, and finally at the end, being forced to choose between nourishment or morphine and being given morphine.

I was here, my family was here, for the accident in '79. We were here for the krypton venting, and really, you know, I have had enough. I get my water from the Susquehanna River. I don't want to drink the waste from Three Mile Island. I don't want to inhale the waste from Three Mile Island, and I think the attitude that you have to protect us against is one that well, they took the accident, they took the krypton venting, they have taken everything for eight years, they'll take a little more. I think really you are bound to stop us taking any more, and I really don't want to turn on my tap and be drinking tritiated water from Three Mile Island, so I think the bottom line has to be that the plant has to be cleaned up. We know that, but the releases to the environment do not have to go on. That is undoubtedly the cheapest way to do it, but it is also the cheapest way to do it in a morale sense, too.

So, you know, I really hadn't intended on speaking when I came here, but I just listened to the comments and evaluated my recent experience. I think it is incontrovertible that exposure to radioactivity does cause cancer in human beings, and I have been through these EIS's before, and there will be three thousandth's of a cancer death, and it will be buried in the population, so we will never know who did it. But, I have seen a cancer death, and it is a horrible thing. I think that even one, one more, whether it's a worker or someone living in Middletown, or someone living in Lancaster drinking the water is one too many. I guess my final comment is I have had enough. I have had enough exposure to radiation already, and I don't want any more. Thank you.

[Discussion]

ERIC EPSTEIN: Eric Epstein, TMI Alert.

Well, perhaps Bill should come up here, because I have compiled 22 questions and never received a formal response, not that I hold that against Bill, but I gleened through the questions and picked out five, which I think he can probably handle, if that is okay with Bill, because I will probably have him parading back and forth anyway.

[Discussion]

Question 21 which I listed and I'm worried about is: Is there an end point to this process? Does this process end precisely at 2.1 million gallons of water? If so, what happens to additional water? I am unclear as to the end point of all this. Is there exactly 2.1 million gallons of clean water segmented off somewhere? What happens to any other water generated as a result of this process?

[Discussion]

That water will be treated as any of the previous water, either evaporated or dumped, if that is the process deemed acceptable?

[Discussion]

Two questions to follow up on this: It would seem to me, what I am concerned with, it would be rather inviting for any other water on the island to be disposed of, either evaporated or dumped, once this precedent is established. What I am concerned about is what mechanism is in place to prevent any additional water or any of the highly radioactive water from being evaporated or dumped at the time? Who is going to make sure that doesn't happen?

[Discussion]

So if I understand you, Bill, then it is possible that what you are saying is the utility would be regulating itself, not to add any more water either highly radioactive or no radioactive water during the evaporation or dumping process. They will be their own police force?

[Discussion]

By physical presence?

WILLIAM TRAVERS: Correct.

ERIC EPSTEIN: Just three more questions. I don't know how I am doing, Mayor Morris, timewise.

ARTHUR MORRIS: You are doing fine.

ERIC EPSTEIN: I guess it is Page 3.12 and Page 3.10, the second paragraph. I was a little shocked to learn --

WILLIAM TRAVERS: Which question?

ERIC EPSTEIN: Question 8. Would the NRC allow GPU to place concreted waste in a trench on site?

[Discussion]

So if I interpret what you are saying correctly, there is a possibility that concreted waste could be buried on site?

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WILLIAM TRAVERS: That's right.

ERIC EPSTEIN: I don't understand what delineates that from being a low level waste site.
[Discussion]
Moving to Question 7, do any of your cost breakdowns take into account inflation, regulatory legal delays, logistical delays, et cetera? And, I was wondering how much of a factor economics has come into play in the disposal of the waste?
[Discussion]
Is it safe to say then it wouldn't be economically prohibitive to ship the waste to Nevada or Washington for those methods of disposal?

WILLIAM TRAVERS: We found that to be the case in what we did.

ERIC EPSTEIN: I will spare the panel and the crowd just one more question. Question 6, I was wondering, do the maximum dose rates assume that all plant, aquatic and human life are chemically and radioactively pure before they're exposed to radioactive emission from the water?

WILLIAM TRAVERS: I'm not sure what you mean.

ERIC EPSTEIN: I mean when you say that a person exposed to X amount of radiation, are you assuming that that person has never been exposed to radiation before, eating food or --

WILLIAM TRAVERS: No. What we have looked at is the incremental risk that could be estimated to be associated with any of the alternatives.

ERIC EPSTEIN: What do you mean by "incremental risk?"
[Discussion]
Those are the five questions I had, and rather than proceed with the other 16, I will wait for the formal response.

ARTHUR MORRIS: Thank you.
Just as a follow up to one of Eric's questions: The on site storage question on low level waste versus not low level waste, that would be contained if it would be followed through with in concrete?

WILLIAM TRAVERS: That is one way it could be contained, but basically there has to be a finding, and again it is not storage. It is actually disposal.

ARTHUR MORRIS: The reason I am asking about concrete, I believe part of this said even in that method, you end up losing 50 percent of the tritiated water in any event.

WILLIAM TRAVERS: Early on. You lose it all eventually.

ARTHUR MORRIS: But very early on, you end up losing 50 percent by evaporation in any event, so you really end up holding 50 percent of it in the concrete or whatever it is you hold it in.

WILLIAM TRAVERS: What you would bind up is the other material.

NIEL WALD: I am necessarily addressing this to the two people at the bar of justice here, but a number of people alluded to the economic factor and the choice of waste disposal being dictated by the economics. I was wondering if I am missing or misinterpreting the table which compares -- Table 5.1 which says that storage in tanks on the site is by far the cheapest method of any of the ten that were looked at by the NRC. Am I correct in interpreting it that way?
[Discussion]

ARTHUR MORRIS: That is storage in tanks on site that you are looking at?

NIEL WALD: Yes. Zero to 1.2 million, which is the upper figure is still lower than any of the lower figures for any of the other methods by anything from a factor of two to six times lower.
[Discussion]

THOMAS SMITHGALL: I'd like to ask one other question. I guess this is for both Bill and for Frank. I'm curious as to whether or not any preliminary bids have been set out or preliminary contracts let or any materials ordered or procured by GPU in anticipation of the evaporation process being approved by the NRC?

FRANK STANDERFER: No actions have been taken of that character. The only thing we have done is asked for bids to supply this equipment so we can understand the cost and the type of equipment better. No contracts would be pursued until we understand we have an agreement on the option. It wouldn't be valuable -- if we signed the contract without the approval to dispose of material this way, then we would be subject to costs to break that contract. So we are just getting the background information we need so that we understand the process better.

THOMAS SMITHGALL: That's all I have.
[Discussion and adjournment]

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Comments Received at the March 25, 1987 TMI Advisory Panel Meeting

RICHARD PICCIONI: My name is Dr. Richard Piccioni. That is P-i-c-c-i-o-n-i. I work with a group based in New York City called Accord Research and Educational Associates.

I think there is another group in this neighborhood called Accord, but it's not the same. We have been in existence since the late spring of 1979. In the early summer of 1980 our group conducted around-the-clock monitoring of airborne particulates and gaseous krypton-85 during the venting of the TMI Unit 2 containment.

We have submitted critical comments to the clean-up proposals that have been published and their revision of dose effects and dose rates which were subsequently released, and we have an active and continuing interest in the TMI situation and the clean-up procedure.

My own credentials are that I have a PhD in biophysics from the Rockefeller University in New York which I received in 1977, and subsequent to that, did three years of post-doctoral research in the Department of Cell Biology and Biophysics also at the Rockefeller, and I was teaching and doing research as an Assistant Professor at the City University of New York, Hunter College for five years.

Currently I am Senior Staff Scientist with Accord Research. It's a non-paying position which I do on a voluntary basis.

In reviewing the proposals for various approaches to be taken in disposing of the water which was generated during and subsequent to the accident at TMI we came across in the proposal which was finally endorsed by this document, The Environmental Impact Statement, NUREG-0683 Supplement 2, the statement that the favored alternative, which involves evaporation, forced evaporation of the some 8 million liters of contaminated water, the forced evaporation will result in the release to the environment of approximately one percent of the estimated one curie of strontium-90 which is present in that water.

I am not in a position to critically evaluate the value of one curie in the contaminated water. I'm taking that as a given, but this isn't anything I say from henceforth and does not constitute any kind of an endorsement of the validity of this number. I wasn't involved in determining it and, frankly, I hope it is that low.

Similarly, the one percent release I won't dispute here just simply because I'm not provided with the technical basis to do so. Again, I'm taking that as a given and I hope again it is that low.

However, what I do want to deal with explicitly are the consequences of releasing into the atmosphere what will be something on the order of 10 millicuries of strontium-90.

Now in this document it's stated and it is not something which is unusual to find in published material from the nuclear industry broadly speaking and with support from the Regulatory Commission that releases of these kinds of say millicuries of strontium-90 are not significant. That is, they do not have health significance. They are far below the releases which are permitted on a routine basis from operating nuclear reactors.

Well, I disagree with that position vehemently, and the basis of disagreement is contained in my appreciation of the biophysical mechanisms of the action of radioactive materials on living things.

Now in this area of nuclear technology and in particular in the area of public involvement in nuclear technology it is very important that the people who are most affected by this technology, namely, the public, understand as clearly as possible what it is that is being proposed in any particular action that is going to be taken and, indeed, what is involved in the whole business of nuclear development.

So we need then to step back a little bit and look at what is involved when you release into the environment radioactive materials.

Consider a single radioactive atom, a single atom of strontium-90. This is a substance whose chemical nature determines where it is going to go. Strontium is an element which has a lot of similarities chemically to calcium.

So when it is released into the environment, a substantially high fraction of it, that is, in comparison with other kinds of materials, enters into the biosphere, namely, that portion of the world which is alive. It enters into it because calcium is a crucial element in the metabolism of plants and animals and strontium, as we said, bears enough similarity to calcium that it is taken in and it becomes part of the biosphere.

Now each strontium-90 atom is traveling through its time on this planet with its own kind of internal death certificate, and sooner or later on the average about half a chance, a 50 percent chance every 30 years, it will undergo decay and in doing so release energy from its nucleus. This energy is released in the form largely of a high-speed electron. It's a charged particle that comes flying out of the nucleus, and this electron that comes out has enough energy in it to cause very drastic chemical disruptions among the molecules that are in the vicinity of the decaying strontium-90. Now so much for the physics. What about the biology and specifically the molecular biology? We know now that living things are alive by virtue of extremely complex and actually rather delicate molecular structures, the genetic material primarily, and that these structures are highly sensitive to the effects of agents such as ionizing radiation which disrupt that structure. They are capable of some repair, but that capability of repair is not unlimited.

There is some redundancy in the biological system, but that redundancy cannot cover all contingencies. So it is known now on a firm scientific basis that every incident of exposure of the genetic material of a cell to the influence of ionizing radiation carries with it a finite chance, a finite probability that the cell that is exposed, that the genetic material which is exposed will be changed, altered in a deleterious way. That is, when you release into the environment radioactive atoms of strontium-90, you are necessarily damaging genetic material of plants, animals and people in the environment. You cannot avoid that if you release the material into the environment. Once you have released it, you can be certain that that effect will take place. There is no way that it cannot take place.

Now the world is large and there is a lot of air, there is a lot of water and there is a lot of space. So if someone miles away from you releases a few billion or a few billion billion atoms of strontium-90, well chances are none of them will reach you or maybe one or two, but they will reach other people, and, in fact, you can be sure that if you are releasing radioactive materials into the environment, say into the air or into the water, that some of those atoms will indeed reach some people somewhere. You can't avoid this as long as your releases are on the planet.

Now the question which gets confused with this basic reality is can the effects be observed and can the effects be measured, not the radioactivity that can be easily measured, but can the effects on people be measured. That question is confused with the non-question that there are effects.

Now I understand how this comes to be because the nuclear industry, its civilian activities, its military activities and its activities which apparently both civilian and military if we are to understand the recent announcement from the DOE of their interest in converting commercial nuclear power plants to plutonium production facilities for the military, maybe it's a mistake to even make a distinction, but all of these activities, the production and testing of nuclear warheads and the operation of nuclear power plants must result in the release of radioactivity into the environment.

It simply has not been developed, the technology has not been developed with the capability of not releasing radioactive materials into the environment and so they are released and so genetic material, genetic information in plants and animals and human beings in that environment is necessarily affected. There is no way that cannot be true.

But, on the other hand, the nuclear industry has a very important stake in asserting, first of all, in making sure that people are unclear on the inevitability of the damage and also in establishing criteria and methods for determining the effects that result in negative finding.

So from the point of view of an independent scientist who is coming to this scene, I have had to take a look entirely at the whole picture of what is released, what do we know about what the effects must be and what are our various tools at our disposal in uncovering and revealing what those effects on people have been, and in particular, evaluating whether those tools are sensitive enough to detect what in effect has to be there.

Now when we monitored the krypton release in 1980, we detected in the krypton plume strontium-90. That strontium-90 was not supposed to be there. There was a lot of strontium-90 in the reactor at that time especially, about 100,000 curies, but the filtration methods were supposed to be good enough to keep the releases down to a level approximately 900 times lower than what we observed.

Now why, by the way -- people may be wondering why did we observe strontium-90 and Met-Ed did not, GPU did not and the EPA did not. It's very simple in case are unfamiliar with the particular history of this. We did a lot of driving and not a lot of sleeping during those two weeks and we made sure that during that time when we were sampling the air, that we were sampling the plume and not background air.

Now the trouble is that since the testing of nuclear warheads began the globe has become contaminated with strontium-90. This is very well known. And if you filter air up or downwind of a nuclear reactor, you will always pick up a certain amount of strontium-90. That represents a background of strontium-90 against which you have to make a comparison when you are monitoring a release. Your ability to make this comparison is limited very substantially by the amount of background air you filter as compared to the amount of plume that you filter.

So we were very active during this period of time and we drove continuously around always staying down wind, and in that way we were able to obtain a very high ratio of plume air versus non-plume air as passing through our filters.

As a result of this, we were able to find nine times as much strontium-90 present on the filters as would have been there had there been no release. So we feel very sure that strontium-90 came out, and these quantities were, as I said, several hundred times, 900 times higher than we had been assured would be released during the venting.

Now again returning to the situation with the accident generated water, keep in mind that the release which is predicted, now predicted in this document for the proposed method is as large as the release which we measured, that is to say, 900 times the release which was promised before the krypton venting by the reactor operator.

Now in our reporting of our findings of the krypton venting and the strontium-90, we found in that plume we made predictions of possible health effects that were going to result from the dispersion of this seven millicuries of strontium-90 which was released.

ARTHUR MORRIS: Can I just ask for a point of clarification real quickly on the 900? You're saying 9 and 900. Is it 900 percent or is it 900 times greater?

RICHARD PICCIONI: Basically, GPU said nothing is going to come out but krypton and it had some extremely low value. We found 900 times that as our calculated release.

ARTHUR MORRIS: Nine hundred times ---

RICHARD PICCIONI: Nine hundred "x".

ARTHUR MORRIS: Thank you.

RICHARD PICCIONI: 90,000 percent.

Now here we have a situation where part of the plan is to release that much, one percent of the supposedly one curie that is present in the water.

At the time when we were evaluating the effects of the seven millicuries that came out from the krypton-85, we predicted that through the mechanism of uptake by agricultural pathways, people eating food, somewhere, wherever there were people eating food grown in this area or from this area, there would be a handful of extra cancers. Our estimates were roughly 20. This was based on a model of dispersion of the percent of the strontium-90 released that would find its way into the food chain and of established values for dose and effect of strontium-90 in adults.

But we were only looking at really one effect which was cancer. Now what I'm here to do partly and why I drove in from New York today and have to drive back tonight is basically to issue an apology for that estimate because since that time, and this was now six years ago, there have been a large number of papers which have been published and evidence which has come to light that the hazards of strontium-90, in particular when introduced into the food supply, are vastly greater than we had thought and that our estimate of 30 cancers or 20 cancers among those eating food contaminated with the release during the krypton venting could be grossly in error, grossly in error quantitatively and qualitatively.

We may have been underestimating the cancers, but perhaps more importantly, we may have been excluding effects on people other than cancer which, in a numerical sense, were far larger, and in particular, the effects on infant and fetal mortality.

You will be hearing in a few minutes from Dr. Sternglass who is one of several people who have contributed to this increasing base of data that give us more reason to be concerned about strontium-90 than we used to be. So I don't need to get into it myself.

But suffice it to say that I feel no less concerned about the effects of releasing into the environment 10 millicuries of strontium-90 now or let's say over the course of the next 28 months than I felt in 1980 when we got the results back from our filters. In fact, I feel quite a bit more concerned than I did at that time.

Now you don't have to release that material into the environment. You don't have to release that one percent, and if we are lucky, one curie of strontium-90. You don't have to do that. You don't have to evaporate that water or dump it into the Susquehanna.

You say that it is possible yourselves in this report, or I shouldn't say yourselves, but in this report it is outlined, an alternative, which is on-site storage accompanied by retreatment of the water in order to separate from the water the radioactive strontium-90.

Now I think this proposal is the only one which is morally acceptable because it does not involve releasing into a highly diffusible medium, namely, the air or water radioactive materials. Those radioactive materials are separated from the water, solidified, and placed in a burial context in which at least there is a chance that their release into the environment will be delayed, and that is vastly preferable to simply letting it go.

Now from that point of view, it is, as I said, the only morally acceptable solution. There is some discussion about what if there is an accident in future involving that stored water, and our reply to that is fine, the consequences of that accident should be mitigated in advance by treating the water repeatedly in order to lower the Strontium 90 concentration which is in that water as low as is practicable and certainly two or three treatments would not be excessive.

Now there is a major advantage to this over releasing it. First of all, you say that there is a curie in there and you say that one percent only will be released, but you won't know that until after it has already happened.

On the other hand, if you are wrong about the quantity that is in there, the quantity of strontium-90, if there is more strontium-90 in there than

you think, passing the water through repeated purifications enables you to know what the heck you're doing before you're in any position that you're going to release it. You pass it through, you pass it through again and you pass it through again and at each stage in the process you have an idea as to whether your predictions are correct.
But if you go ahead with the evaporation, you won't know until it's over whether or not you were wrong again.
So that's about all I have to say and I hope it's been clear.
(Applause)

ARTHUR MORRIS: Do any members of the panel have questions on the testimony at this point?
Niel.

NIEL WALD: You gave a figure of 20 extra cancers out of how many that would have occurred without the strontium?

RICHARD PICCIONI: Hundreds of thousands. It doesn't mean a damn thing. Twenty people dead because of the activity of the nuclear industry. That's 20 deaths. You only have to kill one person in many states in this country in order to yourself suffer capital punishment.

NIEL WALD: I think you answered my second question which was going to be whether these were fatalities or not. Are you saying what you figured were fatal cases?

RICHARD PICCIONI: After the Chernobyl accident, it was stated to the public apparently with a straight face that 25,000 people may be dead in the future as a result of the contamination of the environment with the radioactive materials that came out of that plant, and we were forced to listen to a comparison of that number with the number of spontaneous cancers which would normally occur.
Now I am a scientist by training and I'm supposed to be calm. But this is the one question that gets my blood boiling and you've asked it. It is the essence of the immorality of the nuclear industry that such a question would even be asked.
(Applause)
It is the basis of the industry that the death which is distributed by the nuclear industry is distributed over many people dying of the same cause and that it is statistically hidden and that is how we have a nuclear industry in this country is because of that basic factor of concealment as well as the astonishing moral acquiescence of scientists in that industry to accept these deaths as being somehow insignificant because they are among others that they did not cause.

NIEL WALD: I'm sorry. I'm not sure you answered my question.
No. 1, what was the population in which those 20 extra cancers arose? What size population? If it's 25 people, it's quite different than if it's 25 million people.

RICHARD PICCIONI: No, it is not different.

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NIEL WALD: But you said you used a model and you have to do some calculating. You can't just work with a numerator without a denominator.

RICHARD PICCIONI: You distribute into the environment a certain number of millicuries of strontium-90 and you have a factor which is your estimate of what fraction of that strontium-90 will be consumed. The population size does not matter according to come up with that number. You come up with a population dose, a number of person rems which will be received among all people consuming food that contains that strontium-90.

NIEL WALD: Right, and that's the figure I'm asking for. How many people?

RICHARD PICCIONI: It could be a child in Harrisburg or it could be a child in West Germany eating Pennsylvania cheese. I don't care. The 20 people are as dead distributed over thousands of miles as if they were together sitting at this table.

NIEL WALD: I'm still asking. You mentioned person rem. My understanding of it is you multiply the dose by the number of people exposed to it. So you have to have persons, and I'm just asking how many persons you considered in doing the calculation.

RICHARD PICCIONI: No, you don't. You don't have to.

NIEL WALD: A person rem you don't need persons?

RICHARD PICCIONI: No, you don't. You come up with a percentage, which is the amount of strontium-90 which is going to be consumed. One percent we said of the strontium-90 will be consumed, and that is a certain number of curies. That results in a certain number of person rems. Look at NUREG 1.109. It converts curies consumed to person rems.
[Discussion]

NIEL WALD: Were these fatal cancers or non-fatal, the 20?

RICHARD PICCIONI: The 20 were fatal cancers and you can double it for non-fatal.

JOHN LUETZELSCHWAB: How many person rems did you calculate it to be then?

RICHARD PICCIONI: At that time?

JOHN LUETZELSCHWAB: Yes.

RICHARD PICCIONI: We used a factor of 1,000 cancer incidents per person rem.

JOHN LUETZELSCHWAB: And how many person rems did you calculate from the seven millicuries?

RICHARD PICCIONI: Well, from the seven millicuries we are talking - - we just do the arithmetic the other way. So it's 20. So we are talking 40,000.

JOHN LUETZELSCHWAB: 40,000 person rems from seven millicuries?

RICHARD PICCIONI: Right.

JOHN LUETZELSCHWAB: Back in 1976, the Chinese had a weapons test and the whole East Coast was blanketed with fallout. I don't have the numbers on strontium-90, but I'm sure it's more than seven millicuries, a lot more than seven millicuries. Did you do any work with that incident as to how many cancer deaths were caused from that?

RICHARD PICCIONI: Sure. I mean it's the same calculation.

JOHN LUETZELSCHWAB: Do you have a number then on how many you expect?

RICHARD PICCIONI: Well, no. I mean I don't have a number of how many to expect because we don't have a number here about what the total number of millicuries or curies of Strontium 90 that were deposited where, but it's the same calculation.

JOHN LUETZELSCHWAB: If we take your extrapolation or calculation of seven extra cancer deaths for seven millicuries, and, Tom, do you remember what that was?

THOMAS GERUSKY: (Nodding negatively)

JOHN LUETZELSCHWAB: I would assume it's in terms of kilocuries possibly for the whole East Coast. You're talking about a million times more. So you are talking about 20 million deaths from that?

RICHARD PICCIONI: No, not necessarily. It is not kilocuries on the whole East Coast. It was a small yield bomb.

JOHN LUETZELSCHWAB: Seven curies -- it's 20,000 deaths then. I just have a little trouble accepting that.

RICHARD PICCIONI: How many do you accept?

JOHN LUETZELSCHWAB: Seven millicuries? I would say a fraction of one based on dose calculations.

RICHARD PICCIONI: Well, we differ in our assumptions.

JOHN LUETZELSCHWAB: Okay.
[Discussion]

JOSEPH DiNUNNO: You're concerned in a biological sense with radiological stress on genetic materials. That seems to be where you were heading and the basis of your arguments. What about other stresses that occur as a result of many activities of our industrial society?
If I gather the direction of your argument, you would turn off all radioactivity because of this concern of yours, and I'm not criticizing it,

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but I'm trying to understand where you're coming from. But there must be other things that create similar problems and have you looked at those and are we going to turn all those off as well by your theories?

RICHARD PICCIONI: Well, the first thing we have to do is stop concealing the reality from the public and let them decide.

JOSEPH DiNUNNO: Well, the realities are those that you've just articulated; namely, that radiation does cause damage to biological materials, but this is certainly nothing that has been hidden. This concept is very fundamental and it's been articulated time and time again.
As a matter of fact, it's my understanding that awareness of this has been the basis for establishing radiation protection standards. So it's been basic to the industry.

RICHARD PICCIONI: No, I disagree with that. I think the basis for establishing radiation protection standards is to protect the industry in particular so that there is no single individual or worker who receives a dose which is high enough that they would have a fighting chance in court to prove that their own problem, or it would be the problem of a relative, came from that exposure. By keeping the exposures limited for any one individual, you make sure that the risk is distributed over a large number of people and that way, you are in a much stronger position legally to defend against the attack of any one person that the leukemia that they are dying from or the leukemia that their father died from was caused by that industry.
So the reason for the establishment of those standards is quite clear in terms of the practicality of running an operation such as the nuclear industry in this country. It seems clear to me.

JOSEPH DiNUNNO: Well, that suggests that the entire health and safety protection business has been in cahoots with the nuclear industry, and I find that a bit hard to grasp, but that's what I gathered that you're saying - that you can't trust anybody that develops a health and safety protection standard because that's done to protect the industry.

RICHARD PICCIONI: Well, that's your way of putting it. I don't know.

JOSEPH DiNUNNO: Well, I'm just quoting what you're -- I'm feeding back to you what I heard, and I'm just trying to confirm that that's where you're coming from.

RICHARD PICCIONI: When people talk about releases that have no effect or when the nuclear industry talks about releases that are without effect and that are of no impact to the environment, and you hear statements like this many times a year that various incidents will occur and no effect is expected and these releases are well below regulatory limits. It's a standard method which is used. Workers are exposed to doses up to the legal limit until they have no risk and there are many anecdotes of this, of people who have encountered that.

JOSEPH DiNUNNO: I have to say that that's not true. I have never seen any standard that has not been put in terms of probability. All of these models that you're talking about using, those that you've used, and those that the radiation protection people are all couched in terms of probabilities. So that the probability of these happening always has to be presented in terms of the probability of a number of cancer deaths. One always has to deal in probabilities, and generally, when those probabilities are one in a million and one in 10 million or one in 100 million, then there are decisions or there are observations that are made that these are insignificant risks, but they are always associated with a low probability of some kind or other.

RICHARD PICCIONI: Sure. There are three avenues of deception basically. One is, and I insist upon it, that qualitatively it is not made clear to the public, it is not made clear to those who are working with radiation and radioactivity, that they are exposed to risk no matter what the level. It may be in the BEIR report. It may be in NUREG 1.109, but it is explicitly by active intent of the nuclear industry not in the minds of the people who are being affected.

No. 2, you misestimate what those probabilities are and you close your minds to the possibility that your estimates have been wrong. They have been creeping slowly downward over the year as the evidence has accumulated, but you are way behind the times, and more and more evidence is accumulating that the levels which you say are acceptable and that the probabilities that you are calculating are off by factors of 10 and 100, and yet the NRC is asking for an increase in the allowable occupational exposure to substances like strontium-90. So that's a second avenue.

The third is the releases themselves, the quantities that are emitted and the methods that are used to measure them.

Why can an outfit with an operating budget of zero coming down 200 miles from New York City with a half a dozen guys missing work measure radioactivity that the elaborate trucks of Met-Ed were unable to measure because they were too slow to move around. It's a lack of a desire to prove and find out what in fact is going on.

So there are three levels by which the problem remains.

THOMAS GERUSKY: Can you explain how you did that, how you determined it was strontium-90 on your filters?

RICHARD PICCIONI: Sure. We sent the samples to Teledyne.

THOMAS GERUSKY: And what?

RICHARD PICCIONI: And they did a determination. We calculated the volume of air which was filtered and we compared it to well-known values of the background strontium-90 concentration in the air, and low and behold, it's three standard deviations above and a factor of nine.

THOMAS GERUSKY: And Teledyne is a nuclear industry laboratory?

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RICHARD PICCIONI: They didn't know where the samples came from. If they were in the business of fooling around with their samples, they wouldn't be in the industry. Besides, we've sent them lots of stuff, including dope samples.

JOSEPH DiNUNNO: Doctor, I would like to make another observation, and it goes something like this. One of the things that we in the scientific community do so poorly, as you've indicated, is explain to people what is going on. We try and we aren't always very successful.

I think what confuses people more than anything else is that you can get a group of scientists to talk on a subject like this, and you'll get different views. I'll sit here and I'll give one view and you sit there and you'll give another view, and the people out there don't know which one of us to believe.

We may both be very honorable people, but we aren't doing a service unless we are very thorough and very careful in our statements. We are not serving the public very well. We place them in a position of trying to guess who are the experts and who do I believe.

Tonight we're listening to you and we're listening to Dr. Sternglass. I have papers here that provide comments from very reputable doctors and people from the National Committee on Radiation Protection, very honorable people who have studied this problem for years and years. They differ totally with what you're saying.

Even as a scientist I'm faced with the decision of who do I believe and who do I tell these people out there that they out to trust? It's a very difficult thing.

RICHARD PICCIONI: This problem was decided probably two or three thousand years ago by Greek philosophers who looked into it. You find those who neither profit nor lose by a decision. You don't take the word of people whose lives are invested in the continuance of an industry. Why would you think that those people should necessarily act or should be able to act against their own interests? It's kind of naive.

ARTHUR MORRIS: In an effort to keep things going, I think we're getting into more of a philosophical discussion, which is okay I think, but we have other people that want to speak to the question.

I would like to ask a question, if I may, and that is, you indicated that there is an option that would, I don't know if the word was recommend, but I would sense that from you, that nothing be done at this point other than retreating the water two or three times, I think you said, would not be too much.

My question to you is, you indicated what the content was of the strontium now. What would you anticipate it would be, if you have any idea, after treating it several times, and at what point is that acceptable to deal with and how would you deal with it at that point?

I mean I hear you saying, I think, that no level is acceptable. Can treatment get to that point?

RICHARD PICCIONI: Well, if no level is acceptable, then you can't get to that point. Every time you treat it ---

ARTHUR MORRIS: I'm just asking you that.

RICHARD PICCIONI: From the values which are in this report, it looks like you drop about a factor of 10 every time you run it through the filters. So you starting out at about ten to the fifth picocuries per liter. So run it through three times and keep the stuff on site from now on.
I realize it's an inconvenience, but you should have thought of that before you built the plant.

JOSEPH DiNUNNO: May I comment on that? Reading the testimony that was given last time, that's not correct. As I understand the operation of the filters, the decontamination factor is a function of the concentrations in the material, and as the concentrations go down, the decontamination factor goes up. So that, as you are lowering and lowering concentration, the amount you remove with each pass becomes less and less.
So to go with that last increment that you would like to go, I don't know how many times you would have to go through that, but it would be many times.

RICHARD PICCIONI: It sounds very expensive. I'm sorry.

ARTHUR MORRIS: Well, if I could just for one last second here, at what level, is really what I'm asking you, at what level would be something that you feel then can be dealt with ---

RICHARD PICCIONI: Can be safely stored on site for an indefinite period of time?

ARTHUR MORRIS: Well, is that what you ultimately recommend?

RICHARD PICCIONI: Yes.

ARTHUR MORRIS: That you retreat, but you still store on site?

RICHARD PICCIONI: Yes.

ARTHUR MORRIS: That answers my question. I didn't know that.
Thank you.
[Discussion]

ANNE TRUNK: I would just like to ask if we store it on site, what about all the people that live near Three Mile Island who don't want it on site?

RICHARD PICCIONI: Right. I understand that.

ANNE TRUNK: What is the moral value of that?

RICHARD PICCIONI: The contents of this water are isotopes which are not going to be released outside of any kind of substantial containment. There is no reason to think that there is any way that there are going to be effects on people outside of the boundary of the reactor.

I can't tell you that it's going to be as if you didn't have a nuclear power plant here and it hadn't had an accident, but it did. You did have the accident and you did have the reactor and you did have the accident. The waste has been generated.
I think it is morally wrong to release it into the environment. I'm sorry.

ANNE TRUNK: And I think it's morally wrong to make a dump site right next to my house, you know. It comes down to that.

RICHARD PICCIONI: Well, okay. I'm sure that other members of this panel will be delighted to see a struggle between two victims of their technology, and I think we have to figure out what to do with this.
There may be another alternative which hasn't been enumerated. Among the ones which are listed there, the only one that didn't involve releasing into some neighborhood where people were was to keep it there. But I would be very interested in looking at any other way in which that can be avoided.
But it can't be that we are being put in the situation where the choice is my kids or your kids. It should be nobody's kids.
(Applause)

ANNE TRUNK: Okay. Let's ignore the recommendations from the book. Do you have any?

RICHARD PICCIONI: I don't have any at this time. We have to work on this problem. It's an enormous problem. This is a tiny piece of it. We have radioactive wastes up to our ears from this reactor and from other reactors and from the weapons industry. It's an enormous, enormous problem that we have to start to find out how to solve.
We have to try to get some people together with some professional independence and integrity. We have to start looking at technical alternatives. Are there ways that you can take radioactive materials and keep them away from the biosphere for thousands and thousands of years, irrespective of the cost. We have to start to do that. It hasn't started yet, that process. They are still trying to figure out how to make the nuclear industry work, including how to get that reactor operating again, whether it produces electricity or warheads, and their starting position is there and it's the wrong starting position.
If the starting position was how do we protect people in the environment, we'll come up with answers.

ARTHUR MORRIS: I'm going to take two other questions from two panel members and then we do need to move on here because there are other speakers and we need an opportunity to question them.
I think Niel had mentioned that he had a question.

NIEL WALD: Mine is a comment rather than a question because I'm not sure that in trying to enlighten the public, which is part of the mission of this panel, and we don't work for the industry, the concept of models and the uncertainties, and you as a scientist recognize that when you're working

with a problem where you can't visibly identify and measure an effect, you develop a model and you hypothesize, which means you use your best judgment in constructing the concept which says even though the effects that have been detectable and visible are at a high level of exposure, that in some way I reach the equivalent all the way down to low doses. That's the business of developing a model, and that is the basis for your findings in terms of the health impact and the extra cases of cancer that you mentioned.
I think it does the public a disservice not to make it clear that this is a matter of your judgment and any one who constructs a model makes assumptions and it's a matter of their judgment.
There is a lot of model making going into this because of the need for radiation protection standards, and I have to say, because I worked in Karl Morgan's division, that I object to the idea that Karl Morgan, who is the leading figure in developing radiation protection standards, was doing it to avoid some company out there being sued. That was not why ---

RICHARD PICCIONI: You should talk to Dr. Morgan now and see how he feels about this.

NIEL WALD: Well, I think he did a good job.

RICHARD PICCIONI: By the way, I agree with what you're saying entirely, that it is a dangerous extrapolation to take results on radiation effects obtained really at high doses and high dose rates and extrapolate them down to low doses and low dose rates.
It appears that a simple linear extrapolation tremendously underestimates what the biological impact actually is.

NIEL WALD: One other point I did want to mention is that I think for the human at least that the health impact should be mentioned. You've worked in molecular biology and I know that your frame of reference is different than mine, but my concern is identifiable health impacts and I think there may be a lot of steps in between with mitigating influences that correct for biological damage, especially at very low doses and low dose rates which may prevent the molecular changes that you described from ever appearing as a health impact on the individual that's the host to all those cells, and I think that step shouldn't be blurred.

RICHARD PICCIONI: No, but fortunately there is some experimental data on this and the experimental data are not comforting. They suggest that in fact there may be mechanisms of radiation action at low dose rates and low doses that are not operative at high doses and high dose rates. So that in fact, as I said, extrapolating down may be dangerously optimistic. That's based on experiment.

NIEL WALD: And there are some that point in the other direction.

FREDERICK RICE: You mentioned that we could be grossly in error and maybe we're excluding effects other than cancer. What do you meant by that?

RICHARD PICCIONI: Infant mortality and fetal mortality in particular.

ARTHUR MORRIS: Thank you very much for taking the time to be with us today and be willing to sit here and answer questions for some 30-some minutes.
Thank you.
(Applause)
Dr. Sternglass.

ERNEST STERNGLASS: My name is Dr. Ernest J. Sternglass. I'm Professor Emeritus of Radiological Physics at the University of Pittsburgh. I have been engaged in research in the effects of low-level radiation and techniques of reducing X-ray dose since 1952.
I'm a member of the Radiological Society of America, a Fellow of the American Physical Society, a member of the American Association of Physicists and Medicine, I've taught courses in health physics at the University of Pittsburgh under the direction of Dr. Niel Wald, and I was appointed to the Health Physics Society and recommended by Mr. Thomas Gerusky.
So these are old friends of mine to whom I'm now going to be able to talk about what has happened in the last seven years since I came to Harrisburg on March 29th and urged the evacuation of pregnant women.
Now we have the unusual and, in some way, the sad and tragic opportunity to look at the actual statistics as to what happened in the last nine years. Time will judge whether or not there really have or have not been detectable effects.
In order to do this, I would beg your indulgence to be able to leave this table and go over there to the projector so that you and the public can see the nature of the evidence that is involved in this matter.
May I do that?

ARTHUR MORRIS: Yes, please.

ERNEST STERNGLASS: Thank you.
(Slide)
I believe that the principal issue that has now crystallized as a result of the discussion we just heard is whether or not --
(Pause due to slides dropping)
I'm sorry about this.
What we have to try to recognize is that the question is not one of whether there is an effect. All of us are agreed that there is some damage from radiation at every level. It's a question of whether it's less or more than we expect.
So what I want to do today is very briefly go over with you the evidence that indeed we have grossly underestimated the effect, that indeed there have been serious impacts on human health wherever nuclear releases have taken place, whether from weapons testing or Three Mile Island or the normal operation of nuclear reactors or the distant fallout from Chernobyl.
Now how do we know that small amounts of radiation are dangerous?
What you have to realize is that for 60 or 70 years diagnostic x- ray work, which has been my field, there was no evidence whatsoever that

small diagnostic doses comparable to a natural background of 100 millirem per year, 10 millirem in a typical chest x-ray, or 200 millirem in an abdominal x-ray, that these doses have produced any ill effects in man at all, especially in adults or women.

The point that I'm now trying to make is that within the last 15 years, roughly since about 1972, our whole conception has changed.

The first person who was responsible for pointing out that we had underestimated radiation effects was Dr. Alice Stewart at Oxford University who in 1957 or '58 looked at why leukemia among children in England had risen so much, and this is the key thing. Until 1957, 12 years after the first atomic bomb test and the very year that Shippingport went on line in this state, she discovered that women who had had one or two or three or four diagnostic x-rays, ordinary diagnostic x-rays during pregnancy had almost 50 to 100 percent, or nearly double risk that their children would die of leukemia and cancer.

Now that is an enormously greater effect than for the adult, typically a hundred times. But what she discovered even later is that the fetus in the first trimester is 10 times more sensitive. So that when we talk about radiation in the environment where women are pregnant in the first trimester, we would expect a thousand-fold greater risk than for the normal adult like you and me.

Now what she did was so controversial that nobody wanted to believe her, and no radiologist and no gynecologist and obstetrician wanted to believe it.

So she went back and collected more and more data until by about 1970 or '72 she had developed a data base of many millions of women who had been, 5 or 10 percent of whom had been x-rayed during pregnancy. And then she found the following direct relationship between the risk of the child developing cancer and the number of x-rays given - one, two, three and there was a direct line relationship in an article published in Lancet in 1970.

This was the most convincing evidence because it had nothing to do with the question as to why the women were x-rayed. It was simply that those who got one got one risk and those you got two got twice the risk and those that had three had three times the risk.

That is a linear relationship which is extremely important and has completely upset our ideas as to how dangerous radiation is.

Now the question was raised that maybe there is a repair process, as mentioned by Dr. Wald, and everyone was hoping that there would be. So that in the environment over a period of weeks or months, there would be less of an effect.

Now it so happened that in Japan Dr. M. Segi at Tohoko University was gathering statistics from the World Health Organization all over the world and published them about leukemia and cancer in children following the atomic bomb tests and this is what he found.

Now the question I want you to look at is do you think there is something like a detectable peak?

(Slide)

Now here is the 1935 to 1968 rate of cancer mortality in five to nine-year-old males, and you can see that until the bomb, there was no increase. All the medical x-rays we were using and using in Japan did not produce a rise in leukemia among children.

But suddenly after the bomb arrived all over Japan and not just on Hiroshima, there was a 600 percent increase in the total number of leukemia per 100,000 population corrected for the change in the number of people.

Now the question is, you have to decide in your own mind, assuming that Dr. Segi's data is correct, and assuming that you can go into the library, as you can, and check this plot as to its correctness, whether or not this represents a detectable effect. And I can only say it is you who have to decide. I am clearly very concerned about the need to reduce the medical x-ray dose.

I've spent my scientific life trying to do this. That is why I was hired by Dr. Wald to help reduce the exposure of radiation to people under necessary medical conditions. But I discovered that fallout was defeating what we were trying to do in reducing x-ray dose, and this is the question that only you can decide.

(Slide)

Now the next question is, was it the worst thing? Actually, no. It turned out that we had overlooked another factor which was not discovered until 1972. In 1972, an article was published in Health Physics, and Dr. Wald was head of the Health Physics Society at one time, and Dr. Morgan was the editor of that journal. He reviewed it carefully and published it.

This article was published in 1972 in Health Physics in March by Dr. Abraham Petkau of the Canadian Atomic Energy Commission - not exactly a wild-eyed radical. He was in charge of the medical laboratory trying to reduce the impact of radiation on human beings.

And accidently he discovered that when you took a cell membrane and irradiated it in water with a beam of medical x-rays, it took three thousand rads or three million millirads to break that membrane. But when he added a little radioactive salt to the beaker and just waited until the membrane broke, he discovered that it took less than one rad to break that membrane over long period of time.

In other words, completely opposite to what all previous animal and other studies had led us to believe. What had happened is that we had overlooked a whole different biological mechanism called the production of free radicals, including O2-. O2- turned out to be the criminal in this particular case. It is a free radical that attacks cell membranes and actually unzips them. And since then we have been able to show that when oxygen does not exist in the fluid, then the effect is much less severe.

Unfortunately, you and I in our bodies have enzymes to protect us to a very significant degree from these biological effects of free radicals. But over the last 10 or 15 years, an enormous literature has sprung up that shows that free radicals have an enormous impact on all causes of death, heart disease, lung disease, emphysema, damage to the urinary kidneys and all other diseases.

This was an article just published in Science a few weeks ago about a conference on the extremely great danger of O2-, which is, by the way, produced by all or most ordinary carcinogens as well as radiation. We overlooked this completely.

What he discovered is that the more protracted the dose was, the greater was the effect, completely contrary to what we had known from animals or the use of radiation in x-ray therapy. When you space it out, there was less of an effect, and that is the reason that we developed a radiation standard based on that assumption, that things could only be better if they are spread out over a long period of time.

But as a result of the fact that small amounts of radiation are more dangerous, the response curve is not just linear the way Dr. Stewart found, but it actually is superlinear and rises much more rapidly in low doses. So that when we extrapolate from data taken up here, and that's the data we had at Hiroshima and that's the data we had from medical therapy of millions of patients and hundreds of thousands of animal studies. All the data existed up here.

We extrapolated down and the extrapolation turns out to be in error by a thousand-fold. All this is in the literature today. But it was discovered long after we committed ourselves to nuclear bomb testing, long after we built giant nuclear reactors on the assumption that linear was conservative and that it was probably in the other direction.

The tragedy has been not that people are evil, but that people were not knowledgeable enough because we just didn't have the knowledge or the understanding of the mechanisms of free radicals like O2-.

(Slide)

Now the question still is how do we know that cancers are changed in adults, because this is what Dr. Piccioni talked about? Well, again, Dr. Segi provided us with the data. He took the cancer data from all of Japan and corrected it for the growth and age of the population. It's called age corrected or age adjustment, and this is what he found for the whole period before the bomb and after the bomb, and you have to judge for yourself, assuming that Dr. Segi is an honest scientist, that there was no increase in cancer rates corrected for age for the total population in Japan from 1920 to 1950, despite their increasing industrialization and, in fact, they are getting ready for Pearl Harbor. They had to build battleships and submarines and had to have electric power plants driven by coal and oil. They had to have chemicals and chemical factories, and yet there was no increase in cancer rates. That is a remarkable discovery that has never been mentioned by the nuclear industry because coal was the only thing that gave us electricity before 1950. And yet cancer rates were not rising.

But within five years after the bombs of Hiroshima and the fallout from Bikini and the subsequent testing in Russia and Siberia, cancer rates rose all over Japan by 40 percent, and I drew here for non-white or Japanese, Chinese, black and Indian people of Asian extraction a curve for cancer rise in the U.S., and you can see it's even larger than that for the Japanese population. There are reasons for this which we are only now beginning to understand having to do with poverty and diet, but we'll talk about that later.

The important point is that it was a clearly recognizable effect and there was no question that here we have a situation where we don't have to. You know, we have to simply rely on models and extrapolations and guesses. We have the statistics, but nobody had wanted to look at them. Well then, let's look at the other thing that we just heard about, namely, other effects. Well, one of the things that I discovered while I was at the University of Pittsburgh was, and in Pittsburgh working on radiation reduction for x-rays, that infant mortality suddenly stopped going down when bomb testing started. It's very simple.

For the white population it leveled off during the period of bomb testing and then resumed its decline afterwards, and, for the non-white population, it did it even more drastically with real peaks occurring clearly at the height of nuclear bomb testing in 1957 and '58.

(Slide)

Now the question is this really due to radiation, and this is a perfectly legitimate question. We produced a lot of DDT, we produced an awful lot of other things in the environment, and the question is how could we isolate it, and that's really the big problem. We have all kinds of chemicals in the environment which affect congenital defects, which affect cancer rates and there is no question that all these things combined are very serious for our society today.

But there was something that relates to what we're going to be seeing here, namely, the airborne release of relatively small quantities of strontium-90. This occurred during the time of nuclear bomb testing.

And if we're willing to look at history and learn from it, then we need to look at the data. And what we should look at is something very far from where the bomb was detonated, like 2,000 miles away. There the radioactivity was relatively low and comparable to what we're going to get, or what we did get, from Three Mile Island and certainly much more than what we get from Chernobyl and Europe, but that is what we need to do.

(Slide)

We must now, in view of all the findings of Dr. Stewart, look at infant greater sensitivity in utero. And I've plotted here for you taken straight out of the U.S. Vital Statistics infant mortality in New Hampshire which, as you know, is very far from the bomb test site in Nevada. And here we see this steady decline of infant mortality and some jagged peaks followed by a further decline after the bomb testing ended.

And I've also shown the number of kilotons of bombs detonated in Nevada 2,000 miles away tremendously diluted by the time it got to New Hampshire and thousands of miles away in the rain. Coming down with the rain in the mountains of New Hampshire, we see peaks that correspond exactly to the yearly releases of kilotons, not megatons, but kilotons in Nevada with small amounts, 20 or 30 picocuries per liter of strontium-90 in the milk at the time, and that compares with something like 100,000 picocuries per liter of strontium-90 in the water that is stored now here in your plant on Three Mile Island.

This was 20 to 30 picocuries per liter compared to 100,000 to a million now stored in the plant.

Now you can say what did the babies die of? I mean the radiation was clearly not very large. If I walked around with a Geiger counter, it would hardly click. Why? Because strontium-90 produces no clicks on the Geiger counter. Strontium-90 in the body produces only beta rays and there is almost no way to detect it.

In fact, one of the things that we worked on at the University of Pittsburgh are ways of trying to detect substances in the human body that don't give off a lot of gamma rays. It's very difficult. You can use all kinds of things, but it's very difficult to detect strontium-90 at the levels that are even now sitting in that tank. On the outside you get hardly anything. It won't go through steel and it won't even come out of the human body, out of the bone where it's concentrated.

So the trouble is that strontium-90 goes to the bone. The trouble is that there is where the bone marrow is, and the bone marrow is very important as we have only learned in the last 10 years. It protects us through the development of the immune system.

You will remember that many of the people at Chernobyl who were highly exposed were given transplants of bone marrow in order to try to save their lives because their own immune defenses had been destroyed. Dr. Wald himself was involved in treating people who were highly exposed to radiation by an accident, and the problem was to keep them from getting infected because it was infections that would kill them. He managed to save them.

This is why we need work in the field of radiation protection. There will always be workers and people highly exposed to radiation or accidents in a medical environment or in a laboratory where it's used importantly for biological research.

But in the process we learn that the immune system is really crucial. What we didn't know is that the immune system is so particularly sensitive to strontium-90.

Now one of the early indications that the immune system is involved is again something that you can see with your own eyes.

(Slide)

What I did here was I took the data on pneumonia and influenza among children zero to one year and had it plotted up between 1940 and 1975. Now these children died of infectious diseases in the U.S., and you can see that it was coming down nicely as we improved drugs and medical care and diet. But during the time of the nuclear bomb testing, it completely reversed. And only until after we ended nuclear bomb testing in precise coincidence did it begin to come down.

Now again I warn you explicitly that this does not constitute absolute proof. Do you understand? It's epidemiology in which there is no absolute proof. There is only a probability, a certain likelihood that this is due to radiation and not something else.

For instance, there were improvements in drugs in recent years that contributed to the decline. No question about it. But the improvement of drugs could not have produced an increase during the time of nuclear bomb testing, right? So you see that although there is never a simple single factor, we can arrive at the increasing that something should be of concern to us.

The tragedy about this is that many of us, including many of the people on the Board, myself, and other people had no idea about these things before 1950 or 1960 or even 1965 or '70. The trouble is that the advance of biological knowledge has outstripped our technology, and that is a problem.

Now we want to take a look at say well, but nuclear reactors is something different from bomb tests, right? Of course. They are carefully designed not to emit a lot of radioactivity. Some have accidents. Some are badly operated. Some have a design like a boiling water reactor which is worse than releasing more radioactivity because it has a single loop like the one at Peach Bottom than the one, shall we say, at Beaver Valley. The differ in their releases and they differ in their effect on the environment.

But the standards for radiation were set on the basis of what you heard - that the BEIR Committee did cancers in adults and not for death due to immaturity or infectious diseases in the newborn. The tragedy is that we didn't know about this when the standards were set, and when billions of dollars were invested in new plants.

The tragedy is that nobody knew, neither I nor Dr. Piccioni nor Dr. Wald nor Mr. Gerusky, none of us could anticipate back in 1950 or '60 when we went to school that these kinds of effects would turn up 20 or 30 years later. Nor did people know about asbestos when they insulated all the school buildings with asbestos, nor did they know about DDT when they tried to defeat malaria that it would have these deleterious effects, or PCBs, which was a great thing for transformers, that it would have such a biological effect.

The tragedy is that the particular contaminant we are talking about, unlike PCBs, makes atomic bombs. That's what our federal government is interested in and that is what the NRC is primarily concerned with and the Atomic Energy Commission and the DOE from which they sprang. They were responsible for the security of this nation and it was felt imperative that we had to have plutonium and that it had to be produced at a reasonable cost.

ARTHUR MORRIS: Dr. Sternglass, in all fairness I realize that this is a subject matter that I'm sure you could speak on for hours as background. It is important to try to get to the point. It's 25 minutes into your presentation and we had you scheduled for 30 minutes. We can be a little flexible in that but ---

ERNEST STERNGLASS: Fine. I try to finish in five minutes or so.

ARTHUR MORRIS: Well, if you need a little longer, fine, but we hope we have a chance to ask you some questions.

ERNEST STERNGLASS: Absolutely.

(Slide)

Now what we looked at is strontium-90 around a nuclear plant in Connecticut, and the levels near the plant as measured by their own people were higher than it was during the height of nuclear bomb testing in Connecticut. It centered right on here. When I showed this to the NRC, or the AEC at that time, they said this was Chinese fallout.

(Slide)

This is what happened to the cancer rates around that plant, and you can see that, going away in every direction, the greatest cancer increases occurred where that plant was located, directly taken out of U.S. Vital

Statistics and the State of Connecticut Statistics as published in an article by the Environmental Policy Center.

Now we quickly return to Three Mile Island. Now, you remember there was a question about infant mortality had really changed. Now, by 1983, we see that it never returned to its baseline in the United States even though nuclear testing stopped. But in areas like Wyoming where there was no nuclear reactor, infant mortality returned to its projection of about 60 percent of the total U.S. value because there are no nearby nuclear test sites and no nearby nuclear reactors.

So you see that you have to decide whether or not there is something to worry about. This is Pennsylvania compared with Maine and infant mortality declining. Maine was higher. Then during the time nuclear bomb testing both leveled off. But after nuclear bomb testing, Maine declined sharply and Pennsylvania hung up there because we did not know how serious radioactive releases were and they were high. So that infant mortality rose relative to Maine and only after the Three Mile Island accident did it suddenly drop from 13.2 to 9.8 in two years, a 20 to 30 percent drop when the source of pollution was shut off.

As you can see, whenever one has such a situation, one has the suspicion, the probability, that when you shut off a certain source that the effect declines, as it did with the cholera epidemic in London, then this is likely to be causal related.

Again, it's not proof.

But now let's look a little closer at Three Mile Island. You remember where it is located relative to the other states, Connecticut over here, New York up here and Ohio in the other direction, and Maine. It drifted all over New England and up into the north. So we should see the effects everywhere, shouldn't we? - if there were distant effects the way there were from bomb testing.

Well, here it is in Maryland, and here you see a decline in infant mortality followed by a rise as in Wyoming and then a decline and then we see a black area. This black area represents retrospective correction of the originally important infant mortality in subsequent issues of the U.S. Monthly Vital Statistics.

And when the final picture was in three or four years after the accident, there was a clear peak at Three Mile Island and the official U.S. Monthly Vital Statistics, and after years of correction, the truth finally came out.

In fact, here in this area as just one example, this shows you what infant death rates according to the Pennsylvania Health Department's report happened during the time for infant death rate for portions of South Harrisburg that lay within a 10-mile radius for the April-June quarter, which is the quarter in which the accident took place, and you can see that between 1978 and 1979 there was a rise of 158 percent in that death rate.

Now you have to ask, but is this all? No. In Maryland we see during the time of the release that Dr. Piccioni's group warned us about a clear rise from 58 to 124 deaths a month which I'm sad to say had disappeared the next year from the next issue of infant deaths for the U.S. Monthly Vital Statistics.

Finally, let me show you what happened in upstate New York.

(Slide)
In upstate New York, we had three giant peaks during the 1979 year period every month. That's because, on occasions, the wind would blow north here and here and here, and we got these enormous statistics going from 145 deaths up to 220, a highly statistically significant change because these are one sigma error bars. One sigma means that it is a one -- roughly a chance equal that it is an error -- it's simply a statistical fluctuation. So when you have two or three or four statistical errors, or a peak of that size, it is highly unlikely that this is accidental. Finally, let me come to what is regarded in my mind as a most important piece of evidence.

(Slide)
We collected from the U.S. Monthly Vital Statistics the death rate for infant deaths from 1970 to 1983 and plotted it for every month right out of the U.S. Monthly Vital Statistics, and now you will see what a tremendous data base we now have.

We see fluctuations seasonal, generally higher during the winter and lower in the summer. We plotted the Chinese bomb tests and there is no real strong evidence that the Chinese fallout produced anything. Furthermore, a reactor similar to the Three Mile Island one began operating in late '78, but it had a lot of troubles and it operated in the northern part of Ohio. So it didn't have many releases and when they let them go it mostly went to Canada. So you see there isn't very much in the way of any evidence.

But now let us compare this with upstate New York over which we know the Three Mile Island drifted and here we see the following.

(Slide)
Let us first look at the first part, and you see like Ohio there was nothing unusual in upstate New York. It showed the normal seasonal variations. But finally after Three Mile Island went on line, we see an increasing number of giant peaks, and then during the time of the accident three more peaks, and then during the time of the venting three more peaks and then a decline to an all-time low of only 4.9 cases in the latter part of '79 compared to 27.4 per thousand or 276 cases versus 53, a highly significant decline.

More than that there was another peak that we discovered by accident in '82 and it was associated with a known break of piping between the primary and secondary loop in Ginna reactor in Rochester, New York.

Finally, what does it all tell you? The point is I cannot tell you what this means. I cannot make up your mind whether to believe the projections of the industry and the NRC and the AEC that gave the blessing to the bomb testing and the design of the reactors or to independent scientists like Dr. Burtelle, Dr. Bruce, Dr. Piccioni, myself, and numerous scientists all over the world who were not connected with the industry.

We each have our biases. I certainly would always say that I strived all my life to find ways to reduce x-ray doses to people, but I'm fallible. The real point is that you have to decide in the light of probabilities like a jury, not whether there is absolute certainty that I'm right, but only whether it is possible that I may be right.

Thank you.

(Applause)
I'll be glad to answer any questions.
Also, let me say that I have for each of you copies of a paper that I just published that contain many of these graphs. I will also distribute among you copies of some of the key graphs that I just showed you so that you can take them home and ponder over them yourselves.

ARTHUR MORRIS: Thank you, Dr. Sternglass.
Maybe if you would like to return to the table and see if there are any questions.
Joe.

JOSEPH DiNUNNO: I have a couple of questions. I think he should stay there to put a couple of his viewgraphs back up. I'm just trying to put into perspective the data that he presented versus the kinds of releases that were being talked about in terms of this water problem that we're trying to develop. I'm trying to find the relationship between what I heard and the issue before the table.

ERNEST STERNGLASS: Well, I'll be glad to address it.

ARTHUR MORRIS: Before we do that, if we could let's realize that we are here to discuss really the disposal option and the PEIS.

ERNEST STERNGLASS: I just simply had to set it into perspective that a projected release which was presumably comparable to the venting that was believed to be safe of some 50,000 curies of noble gases back in '80, and that release, as you may remember, and on the material that I'm giving you showed a clear peak of infant mortality in the second half of 1980 relative to the first half.
That's what I'm trying to do, to show you that historically what was believed and was advertised by the industry and guaranteed to be absolutely safe so that the people who objected to it were poo-pooed, okay, that they were right and that we have indeed underestimated the effect.
I'm saying we need to look at old history in order to learn from the past or else we will have terrible problems if we do not examine the past history.

ARTHUR MORRIS: Joe.

JOSEPH DiNUNNO: Just two points that I think I would like to have you address. The curve that you were showing, the curvalinear dose and the linear relationship, I quickly noticed the abscissa, the numbers on the bottom and they went from zero in effect up to 100.

ERNEST STERNGLASS: Right.

JOSEPH DiNUNNO: But those curves converged pretty much down in the 10 rad area. If you look at that curve, that suggests a great deal of uncertainty once you get down in the millirem and fractional millirem that would be involved in this release. You're informing people of what you suspect or what you would theorize happens at very high dose levels, but you have to address for their benefit the uncertainties that are involved once you get down in that very low range.

ERNEST STERNGLASS: I'm glad you asked that question.
(Dr. Sternglass returns to the slide projector)
(Slide)

I'm sorry. I have so much more material that I was unable to show you. But here is a curve taken from data by Dr. Stocke and his co-workers at Oslow Cancer Hospital published in about 1968, and it shows the strontium-90 does to bone marrow in millirads for rats in which he injected small amounts of strontium-90 at levels comparable to the ones we're going to expect here at Three Mile Island.

This is a percent depression in bone marrow cellularity that he observed, and you can see that it rose very rapidly, just like the other curve I showed you, at very low doses and then leveled off at high doses.

Now at the time we did not understand it. In fact, we extrapolated and expected to be down here. But the actual effects that he could see microscopically in the rat bone marrow was as much and so clear that there is no question now that we totally underestimated the effect of free radicals at very low doses. And that is the problem of the advance of science when our technology is frozen in.

The reference to this is given in the article that I've just distributed to you.

JOSEPH DiNUNNO: One other question while you're there, Dr. Sternglass. You also presented a large amount of data to begin this off dealing with the effects of radiography, the use of x-rays.

ERNEST STERNGLASS: Right.

JOSEPH DiNUNNO: But there are no indications of dose levels that are associated with those. So they lose something there.

ERNEST STERNGLASS: Exactly. A typical x-ray gives about 200 to 300 millirems to the fetus. We are talking about background radiation levels of about a year and a half worth of radiation.

Now for the case of the fetus of the first trimester in the embryo the slope is ten times greater and we are talking about a doubling dose of about 90 millirads. Now more recently, just now, and I'll be glad to show you a copy of the paper, Dr. Alice Stewart did a study on the effect of background radiation on leukemia and cancer in England and discovered from measurements of background radiation all over England, a paper she just presented at an international meeting, that 90 percent of the leukemia and cancer among newborn can be attributed to background radiation and only about six to seven percent to medical x-rays.

So we are talking about a doubling dose of a first trimester of only 40 millirads. That means that if the three millirads to some group of the population which is admitted in the volume that we have seen of the environmental impact statement, then we would expect a certain increase, proportionally a 10 percent increase in leukemia and cancer rate among the children.

And since about 2 million children, or 2 million individuals will live within the 50-mile radius and about 10 million within a 75-mile radius, we certainly would expect something like 20, 50 or a few hundred infant deaths of which possibly 1 to 10 percent would be leukemias and cancers. So we have data at the low dose level of what we're talking about.

JOSEPH DiNUNNO: Isn't it true, however, that the data that you have at these lower levels becomes more and more speculative as you go down?

ERNEST STERNGLASS: No, not at all, because there was a very careful study done in England by the Public Health Service of the British Government. They studied the radiation levels every 10 kilometers all over England and Wales, and Dr. Stewart had accumulated the evidence on 16 million women who bore children in England and Wales since about 1950.

Her data now shows that in every area like London, areas that have low background radiation had a low incidence of child leukemias and cancers and areas that have high measured levels of radiation had almost twice the incidences. So we are talking about an extremely carefully done study that involved close to somewhere around a few hundred million man-years, person-years, of radiation followup, the largest study of its kind.

ARTHUR MORRIS: I see John's hand and then Niel. Was there another one here? Okay.

JOHN LUETZELSCHWAB: Let's go back to the 1976 Chinese bomb test. I had sampled my garden as a matter of fact and I found iodine, lanthanum, and some cesium, of course, that was there from years ago, too, and I assume there was Strontium 90, but I didn't check for that because I can't do that. I was measuring gamma radiation.

Yet it doesn't show up in any of your data. I'm surprised because the levels I assume that came from that test that blanketed New York and Pennsylvania were much, much higher than came from the accident, from the venting or anything. Why don't you see that on any of your statistics here?

ERNEST STERNGLASS: As a matter of fact, I presented a report, and I'll be glad to give you a copy of it, to the National Academy of Sciences on the October 1976 Chinese fallout. It's referred to in the BEIR Report. And in there I showed that all along the coast of the United States during the time that we monitored that terrible fallout from the October '76 cloud there was a 20 to 50 percent increase in infant mortality per month during each month beginning about the second to fourth month after the fallout arrived.

It was not observed in Massachusetts where they had taken the cows off pasture, and that report I'll be glad to send you a copy of.

JOHN LUETZELSCHWAB: But that's just iodine. What about strontium-90 which is in the food---

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ERNEST STERNGLASS: At the time we don't know all the doses, but my correlation at that time was carried out with iodine. And we don't have to forget that there will be iodine released. We are talking about I-129 at least as one of the isotopes that goes to the thyroid, and the amount of iodine-129 is much more damaging in the long run that I-131 because I-129 has a half life of 16 million years and will be recycled again and again in the soil and in the animals that die and the food. Again and again over the years we will have effects due to this I-129 that you propose to release.

ARTHUR MORRIS: Niel.

NIEL WALD: A couple of questions, but first a comment. It's nice to see that we picked a good lecturer when we brought Dr. Sternglass to the University of Pittsburgh. Of course, we brought him as a radiation physicist and not a biologist or epidemiologist.

The work of Alice Stewart that you've mentioned, and you've leaned rather heavily on your dose estimates of what these x-ray studies involved in the way of radiation exposure, but, unfortunately, these were not reported or measured by anyone at the time, and the number of x-rays is the recall of the memory of the mothers who were surveyed. They were asked how many x-rays were taken, and this is a very solid basis on which to draw a dose response curve and then insert a dose estimate which was to replace the missing dosimetry.

In other words, what I'm saying is that you can't lean as heavily on data -- more heavily than the data itself justifies. While this is an interesting epidemiologic study, there are some problems with it, this being one of the major ones.

Another major one is that the finding should have led, if it was correct, to an increase in the incidence of leukemia in the children who were exposed in Hiroshima and Nagasaki who happened to be in utero at the time of the bombings and that increase has not been seen. So it is not a uniform finding.

I think the figure she used, incidentally, is not 50 or 100 percent, but 40 percent I think was her best estimate.

On Petkau's work I believe that the membranes that he worked with were artificial membranes rather than actual living cells, and while I certainly think it's interesting work, it's a little hard for me, again with my health perspective, to jump from an artificial Mylar film like Saranwrap and consider that the same as the cells that we're made of.

ERNEST STERNGLASS: I'm sorry, it was not Saranwrap.

(Laughter)

It was beef brain lipids. It was living tissue lipids. Furthermore - are you finished? Why don't you give me a chance to answer the questions. I keep forgetting what you're asking. Let me answer one at a time.

NIEL WALD: I had to take notes to make sure I didn't forget what you were saying and I'm not talking nearly as long.

ERNEST STERNGLASS: You want to put me at the same disadvantage, right?

NIEL WALD: The other point you made about free radicals. I'm just a little troubled because that was something that was recognized many, many years before 1970 and indeed there was a search, as you are probably familiar with, with agents that absorbed free radicals.

ERNEST STERNGLASS: Sure.

NIEL WALD: And as you mentioned, the cells have natural agents which do that. The problem of cancer rising, Dr. Segi, is that --.

ERNEST STERNGLASS: Segi, yes.

NIEL WALD: -- is a complicated one. For example, if antibiotics get introduced into an area which didn't have them, then there will be other causes of death that have to increase because all of us must die, and these changes, it is again an extrapolation or a model, a mental hypothesis which says this is due to radiation, and it may or it may not, and most likely it's a lot of things rather than any one thing.
I make that caution in looking at cancer deaths. For example, all over the world the incidence of leukemia started increasing around 1930, including Japan. That I didn't see demonstrated on this graph and the reasons for this are not clear, but this was a period during which the increase was noted in very many countries all over the world.
So that one has to be careful about drawing conclusions about the cause when one detects a change as the kind that Dr. Sternglass demonstrated.
The background studies of Dr. Stewart, did you give a reference or was this a presentation and has been published?

ERNEST STERNGLASS: The paper is now being published.

NIEL WALD: I haven't seen it. So it's hard to comment since it hasn't come out yet.

ERNEST STERNGLASS: I'll be happy to show you a copy and send you a copy.
So let me try to remember now all the things that you mentioned. Let me work backwards.
Dr. Alice Stewart did indeed have this help from the National Radiological Network in order to determine background radiation everywhere. So that is now a very different question because the dosimetry is well known, unlike in the case of x-rays that had to be reconstructed.
Fortunately, in my business, we know roughly what a dose is during a given time because other people were measuring the doses.

NIEL WALD: I wasn't questioning this one. I was simply pointing out that none of us have seen it because it hasn't been published yet.

ERNEST STERNGLASS: Right.

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ARTHUR MORRIS: Let's do this so we can make some sense.

ERNEST STERNGLASS: Let me finish.

ARTHUR MORRIS: Let me just try to set the game plan here. You made a presentation and we have had a counterpoint. You go ahead and make a point. If Niel wants to make an additional point, I would ask him to do it very briefly so that we can have another opportunity for other people.

ERNEST STERNGLASS: I understand. So let me now address a question of the cancer rates in Japan.

Again, the fact that it recently leveled off and has begun to come down, both for leukemia and total cancers means that despite the increase in pollution and the use of new drugs that there is indeed a decline or a leveling trend in Japan in general, and Japan has now and Iceland and Denmark have lower cancer rates than we do and they are declining while in many parts of the U.S., cancer rates are still increasing.

All we can always say is there is no question that nothing can ever prove it beyond a shadow of a doubt, and there is also no question that the presence of other chemicals will also have an effect just like workers in the uranium mine when they smoke get much greater increases in lung cancer rates than when they don't smoke. So there is no question that there is an interaction or synergistic relation between radiation and cigarette smoking.

Now let's go back to another question that has to do with the amount of radiation given during x-ray procedures. Dr. Alice Stewart had a number of studies done at the time that showed what the typical x-ray dose was, and what is significant is that it is the number of x-rays that increased with the dose.

Furthermore, Dr. Brian McMahon who raised the same question as Dr. Niel Wald did, repeated Dr. Alice Stewart's study at this time with actual hospital records of the number of x-rays given in New York and New England, and he completely substantiated Dr. Stewart's findings although in an absolute sense, he got about 40 to 50 percent as great an effect because of the further improvement in medical diagnostic techniques and the speed of film and so on. But in his case that study answered it.

Furthermore, Dr. McMahon and his associates addresssed the question as to why it was not seen in Hiroshima as did Dr. Stewart. We have to realize that Dr. Stewart had to look at 16 million women in order to discover her effect, but in Hiroshima only a few hundred women survived and had children that were followed up.

And Dr. McMahon himself and Dr. Stewart showed that those few hundred babies that happened to be in utero at the time and survived were too small in number to detect the effect. You literally have to look at millions of cases in order to be able to see it.

And I think these are the kinds of considerations that you have to question yourselves. If you have a family and you expect a baby, what would be your concern. That is what you have to think about, and you have to express your concern in that area and you have to judge between the kind of evidence that Dr. Stewart presents, the kind of evidence that now comes from the University of Colorado showing that in July of last year in the National Academy, there was a 200-fold greater response of human chromosomes to environmental radiation, to lower levels of x-rays than we had ever expected.

Now this is new data. No one can blame us or anybody for not having known about it 10 or 15 years ago. All I'm saying to you now is do not disregard the latest scientific data because it goes against what we had hoped for in the nuclear industry.

[Discussion]

ERIC EPSTEIN: I'm Eric Epstein from Three Mile Island Alert.

What I want to do in order to save time is I have a statement from Michio Kaku. I'm going to read that, and I think my own statement, which is really brief. Should take 10 minutes.

So let me begin by reading Michio's statement verbatim, and I don't want you to confuse his credentials with mine.

Statement of Dr. Michio Kaku concerning the disposal of TMI waste, and this is Michio again speaking.

I am a full professor of nuclear physics at the Graduate Center of City University of New York. I graduated from Harvard University in 1968, Phi Beta Kappa, Summa Cum Laude with highest honors and No. 1 in my physics class.

I received my PhD in nuclear physics at the Lawrence Radiation Laboratory at the University of California at Berkeley, 1972.

I subsequently taught on the faculty at Princeton University and I've been a professor with the City University of New York for the past 14 years.

I have published over 45 articles which are right here if you need to see them for the record and various professional journals and contributed to over six books.

I am the author of Nuclear Power - Both Sides which has since become the standard reference on the nuclear debate and my credentials are enclosed at the back of this statement, and I would move that he be accepted as an expert witness.

I'm going to also when I'm reading some of these abbreviations read them rather than screw up what they might stand for. It's for some of the transuranics and the elements, if that's okay as well.

I have been asked to review the NRC's plans to dispose of TMI waste water as presented in a supplement to the Environmental Impact Statement, Supplement NUREG-0683.

I find several things disturbing about the presentation from a strictly professional point of view. Previous EISs concerning the disposal of radioactive wastes have totaled more than a thousand pages with scores of charts, diagrams, graphs and tables.

In comparison, I find the present NUREG 0683 deficient. It does not reflect careful scientific scholarship and it seems to have been slapped together at the last minute. Many key areas of scientific information seem to have been carelessly left out, making it difficult to make an accurate scientific analysis of its credibility.

The report verges on sloppiness and I hope it does not reflect a deeper attitude towards the clean-up operation. I will list some of the areas that I feel are lacking in scientific rigor and reveal a certain amount of hastiness.

No. 1. The list of radionuclides on Page 2.3, Table 2.2 is a very poor indication of actual radiation inventory of the water. For example, compare it with Pages 7-5, 7-6 and 7-7 of the original EIS published six years ago and we find that the current list omits many important radionuclides originally tabulated by the NRC.

Some of the radionuclides that are left out by the NRC in the current volume are important, including, and here again here are the abbreviations, MB/95, ZR/95, SP/125, TM/125M, TE/127M, TE/129M, CO/58, TE/I/129M, RU/103.

Thus, it is difficult to evaluate the present EIS supplement because it is deficient in this important analysis. This is a significant point because there were literally hundreds of radioactive chemicals dissolved in the reactor building and sump water making it a virtual soup of radioactive elements.

The ion exchange mechanism of the SDS and EPICOR II does not filter all elements identically (and, in fact, does not filter some elements like tritium at all).

So we must have a careful reading of precisely what all is presently in the water compared to what it contained in '81 when the first EIS was compiled.

Point No. 2. Even though the original EIS of March '81 failed to make a complete radiation inventory, for example, neglecting to compute the transuranics contained in the water, in a normally functioning 1,000 megawatt reactor, for example, the accumulated high waste within 100 tons of uranium dioxide is about 30 tons of which 500 pounds consists of plutonium.

Most of the plutonium is reactor grade plutonium-240. Most of these transuranics are not water soluble compared to iodine or strontium. However, they certainly exist in the water.

I mention them because the transuranics are some of the most toxic chemicals known to science. The low levels of concentration in the water are compensated by the fact that they are quite toxic. Yet no mention is made to them in either NUREG 0683 of six years ago or the present EIS.

Point No. 3. No mention is made of how the radioactive levels in the water were obtained. Given the fact that the original radiation inventory exceeded half a million curies, this is not a trivial question. Thus, it is impossible to give a detailed assessment of the accuracy of the radiation levels because no indication is made of how these measurements were taken and how reliable they are.

Statements of the willingness of utilities to drink this water are not scientifically relevant and in fact are misleading. I refer you back to Herman DeCamp's quote that the water is so lowly radioactive that he would drink it.

FROM THE FLOOR: Give it to him.

ERIC EPSTEIN: We'll give it to him.
(Laughter)
Where is Herman tonight?

Point No. 4. The tritium count in the water raises some concerns. Originally there was 2500 curies of H-3 in the reactor building sump water. The EPICOR II and the SDS of course cannot extract out the H-3. The filters work on the principle of ion exchange as in a water softener. So that H-3 cannot be removed.

However, the present EIS only lists 1,020 curies of H-3 on Table 2.2. Where did the other two-thirds of the tritium suddenly disappear to? Normal radioactive decay cannot account for this because H-3 has a half life of 12.3 years. No mention of this discrepancy appears in the EIS. The present EIS gives a misleading interpretation of the properties of tritium on Pages 2.5 and 2.6. At best, it is self-serving and at worst, deceptive.

The EIS only takes selective quotes from the NCRP, the National Council on Radiation Protection Measurement and omits others which may show the hazards of tritium.

For example, the EIS quotes the HTO has a 10-day biological half life in the body, but neglects to say that HTO can also be incorporated directly into cell membranes where it becomes a rather permanent part of the body's chemistry. Thus, the radioactive HTO can irradiate body tissue over the life span of the individual causing possible radiation damage. Thus, the figure on the biological half life in the body is not indicative of the actual body burden of radioactive materials one may incorporate into human tissue. Yet, no mention was made of this.

Some rather feeble attempts were made to calculate radiation exposures to the tritium at a distance, but no attempt is made to calculate tritium that is incorporated into the body itself and, hence, irradiates the body at a close range.

Point No. 6. Because water is everywhere in our environment and since HTO is chemically identical to water, the pathways for ingestion or inhalation of this water are non-negligible.

Because the utility is making preparations for a possible boil-off of this water into the air, it becomes a significant question of how much of this water will eventually become ingested into the human population. Boil-off, evaporation or river dumping all have the same net effect of releasing HTO into the environment where it can be picked up by living organisms.

I find the analysis of how much radiation can be ingested in humans from an evaporation or boil-off wholly deficient in the report. It appears as if the authors of the report simply dashed off this section on environmental and health hazards as an afterthought.

Point No. 7. The EIS does not mention that the radiation standards for beta radiation may soon be changing. The T-65 dosimetry, which was originally used to calibrate the radiation from the Hiroshima bomb, is not known to have been miscalibrated.

Recent work done at the Livermore National Laboratory which designs hydrogen warheads has shown that neutron levels probably cause less biological damage than previously thought, but that electrons and gamma rays do more damage. This is significant because the Hiroshima data is perhaps the largest of all the epidemiological studies on radiation health effects outweighing all the others.

A recalibration of the Hiroshima data with the correct numbers for beta radiation may show that chemicals like HTO are more dangerous than previously thought, forcing a revision of the NCRP data. Yet no mention is made of this in the EIS.

Point No. 8. The NRC makes no mention of the reliability of the vendors and companies which may eventually carry out the release of this water into the air or river.

Normally it is not that essential that the EIS address this question. However, given the rather unsavory documented history of past deception, some of it conscious and some of it bordering on the criminal, it is not too much to ask the NRC to thoroughly evaluate the reliability of these companies and the role of the utility.

Point No. 9. Not enough attention is paid to the negative effects of river dumping, both commercial and environmental. As an example, consider the fact that 90 percent of the value from Chesapeake fisheries comes from shell fish, a luxury item for many restaurants and hence, highly subject to people's perceptions of how safe it is to eat the shell fish.

The well-publicized dumping of the insecticide Capone and other pollutants in the 1970's in the Chesapeake caused enough negative impressions for the consumer to have a sizeable economic effect on the Chesapeake economy. The adverse effect on the sale of oysters and blue fish is well documented causing an economic loss to the area.

Dumping of TMI waste water into the river could very well have a negative effect on the economy of the area given the fact that much of the economy rests on the luxury items that are highly susceptible to changes in people's tastes.

Point No. 10, and the last point. In summary, I find the present supplement to the EIS is not very valuable from a scientific point of view. The NRC has not done its homework and it's hard to make a reasonable scientific conclusion given the paucity of scientific information contained in the report.

At best, it shows a certain insensitivity and a lackadaisical attitude towards radiation safety and at worst, it shows an inclination to disregard the health and safety of the people in Harrisburg.

That is the presentation of Dr. Michio Kaku. I might have read it too quickly and I hope you were able to all comprehend it.

Since I am not a technical expert, I'm not disposed to answer any questions you may have. But what I will do is make some copies available perhaps at a later date to the Commission because I think Dr. Kaku is a reknown world expert and I think his opinion is much valued.

[Discussion]

ERIC EPSTEIN: I'm just going to make a brief statement because I think I've said all that I really wanted to say at the other meetings. I just hope for a change that somebody from an NRC-affiliated body listens, and that would be a delightful change to past actions of the NRC in the past.

I'll just read briefly.

We've gotton so used to being ignored and having NRC-affiliated bodies rule against us that I appear here tonight hoping for once that a decision will be rendered in favor of the residents of Central Pennsylvania.

I feel we must not become so desensitized by the statistics represented by GPU, the NRC, and DOE that we lose perspective of what's at stake.
Again, rather than make any more statements or point to GPU's past history of misconduct and misdeeds, I think it's important that you take the time right now to heed the advice of John F. Kennedy when he urged the ending of above-ground nuclear testing.
And I quote: "The number of children and grandchildren with cancer in their bones, with leukemia in their blood or with poison in their lungs might seem statistically small to some in comparison with natural hazards, but this is not a natural hazard and it is not a statistical issue. The loss of even one human life or malformation of one baby who may be born long after we are gone should be of concern to us all. Our children and grandchildren are not merely statistics towards which we can be indifferent."
That concludes my presentation.

ARTHUR MORRIS: Thank you, Eric.
(Applause)

JOEL ROTH: The question I'm about to ask you -- we are the break were trying to come up with some answers and perhaps you could help me on that.
As far as numbers of people who you feel are truly concerned with this issue, and I know you said to me tonight that you had received a lot of calls, and I've received some calls, but is there any way you can help us, you know, with just some type of numbers or feeling that you have gotten on the people who are truly concerned?

ERIC EPSTEIN: Well, I really can't give you an accurate number based on the phone calls that I get and the people I talk to. I can tell you that anybody I talk to and have come in contact with is adamantly opposed to dumping the water and evaporating into the river, and I think that attitude stems from their perception of GPU and the NRC as not operating in their best interests.
I don't think faithfully, Joel, I can render you a figure of how many people. I can just tell you that overwhelmingly not one person has said to me that they are in favor of dumping it or evaporating it into the air.
This is the first time since the restart that there has been this much public interest converging on an issue. I mean the phones are ringing off the hook and we are getting letters and requests on the scale that we had at the point of a restart decision. So there is a lot of attention focused.
I think the reason that you may not see numbers like you used to see is because people are apathetic. I mean to some degree the NRC, and I don't know how to say this any more delicately, has screwed them and so has the utility.
(Applause)
I really think you have a unique opportunity to reverse that trend and perhaps show some courage and make the decision that is favorable to the residents of Pennsylvania for a change. That's the only way I can truthfully respond to that question.

JOEL ROTH: Thank you.

ELIZABETH MARSHALL: Mr. Epstein --

NIEL WALD: Can I follow up on that?

ARTHUR MORRIS: Yes. Niel and then Elizabeth.

NIEL WALD: I just wanted to ask whether you detect any public favor for keeping the water on Three Mile Island?

ERIC EPSTEIN: Well, I think a lot of people are comfortable with that idea because, first of all, I think people are tired of being dumped on, and any perception of anything being evaporated or dumped on them was a perception of them being exposed to more radiation, which I think is an accurate perception.

I think there is a feeling from a lot of people that they could deal with the water staying on the island until a safer method of disposal is found.

NIEL WALD: And they would trust GPU to --

ERIC EPSTEIN: I don't think they would trust GPU to do anything, you know, but I think there would be a lot more trust -- let me be frank with you. There would be a lot of trust for them to keep it in the water where it can at least be monitored rather than have them disperse it into the air or dump it into the water. And I think that people are just tired of being dumped on.

I'm not saying that they would trust the NRC or the EPA or the DOE to do it, because I don't think they would. I don't think you can regain the level of trust from this community that you once had before the accident - ever. I think that's gone.

NIEL WALD: No, I'm just looking at the water problem because I remember there was a lot of objection to Three Mile Island being a waste disposal site.

ERIC EPSTEIN: Yes, I agree, and I've sparred with Tom about this before and I'm not going to get into now, but I think there is that potential in the future that the fuel pools will be utilized in that capacity.

But I'm taking other people's time.

ARTHUR MORRIS: One last question.

Elizabeth.

ELIZABETH MARSHALL: Niel asked the question I was going to ask.

ARTHUR MORRIS: Okay. Thank you, Eric.

ERIC EPSTEIN: You're welcome.

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BRENDA WITMER: My name is Brenda Witmer. I'm from Lancaster and I'm a member of the Susquehanna Valley Alliance. I will be reading the statement of Carl Johnson who is a medical doctor and Director of the Health Department of South Dakota University. He is also an expert witness in a court case. It was an important case reflecting the health effects of workers at Rocky Flats.

This letter was written on February 21st, 1987.

I have reviewed this draft supplement and wish to make the following comments.

In the Summary on Page v, I note that the disposal volume of accident-generated water was 'expected to be 40,000 to 80,000 cubic feet (11,000 to 13,000 cubic meters)'. I believe that cubic feet have been converted here into square meters and not cubic meters.

In the second paragraph of the Summary, I see that the final processing will involve about 2.1 million gallons, or 7.9 million liters with about 1,000 curies of tritium and smaller amounts of cesium-137 and strontium-90. There is no mention here of uranium, plutonium, or other transuranics nor of other of the 500 different radionuclides of potential importance in the assessment of contamination around nuclear facilities. This is a very serious oversight. I believe that the concentration of all of these should be determined.

The summary estimates that the considered disposal alternatives will have an impact of only zero to .003 radiation-induced cancer deaths in the worker population and only zero to 0.0003 for radiation-induced cancer fatalities in the off-site population.

If this water is really that innocuous, should the plant save it to be used in drinking water fountains for the employees at the plant or should it be carbonated, bottled, and sold in stores as spring water?

As I recall, the reactor core in this plant was partially melted down and this water has been in and around the 100 tons of partially melted uranium with plutonium and other activation and fission products for nearly seven years. Many of these metals and compounds are quite water soluble, especially uranium.

The Schwarzwalder Uranium Mine, for example, in Golden, Colorado at times pumps out more than a million gallons of water each day, and in the past and perhaps today also this has been discharged into public water supplies. The water at times contains more than 10,000 picocuries per liter of alpha radiation from the uranium.

The contact there between water and uranium ore has been at rather cool temperatures, not in a superheated environment such as has occurred at TMI-2. I can't believe that there is not a large amount of uranium and its progeny and other transuranics dissolved in this water in TMI-2. And yet, in reading this report I didn't see any mention of alpha radiation levels per liter of water, nor of the concentration of uranium and other transuranics in the water.

In the manuscript there was a discussion of background radiation levels in surface waters downstream and these discussed the levels of alpha radiation and radium in the water amounting to several picocuries per liter. The lack of information in this draft report on the concentration of uranium and transuranics in the waste water is very puzzling.

The range and concentrations of radionuclides in the water should be determined by a number of agencies and independent laboratories and the radiation protection guides should be those developed by the EPA or more conservative independent researchers. For example, the EPA has advised a limit of 10 picocuries per liter of uranium in water in contrast to a limit of 6,000 supported by the Department of Energy.

Further, the units in the book should be consistent with the present EPA practice. After all, this is an environmental impact statement. Radiation activities should be expressed in terms of picocuries per liter of water and picocuries per cubic meter of air. The use of awkward units like microcuries per milliliter and the use of large negative exponents should be avoided since these are confusing even to experts and especially confusing to the public.

In several places the text reads as if the tritium in the water is there as a gas. In fact, tritium (which is hydrogen) oxidizes with oxygen and ozone over time to form tritiated water or heavy water. The evaporation process will simply evaporate off all the tritium as a tritiated vapor which is much more toxic on inhalation or ingestion than is tritium gas.

I think that we do not have enough information to make a decision about the disposition of this water. I recommend against any of the methods of disposal at this time until there has been exhaustive analysis of the water by a number of agencies and independent laboratories and universities, including one or two in Canada.

The water should be analyzed also, for example, by the EPA and by the U.S. Geological Survey which does get involved in what happens to water in the environment. I have attached a figure from an EPA report on liquid emissions from a nuclear power plant in normal operation to show the range of radionuclides released in such normal operations.

I think we need to know more about the assumptions made in calculating doses to persons around the plant from the radionuclides which might be released by the various alternatives proposed.

Those dose estimates should also include exposure to every one of the 500 radionuclides of potential importance in this water and should also consider concentrations of radionuclides by marine plants and animals in the food chain.

Sincerely, Carl J. Johnson, M.D.

And here is the little chart that is included.

[Discussion]

FRANCES SKOLNICK: My name is Frances Skolnick. I'm with the Susquehanna Valley Alliance.

Dr. Wald, when you discussed Dr. Stewart's study with Dr. Ernest Sternglass you mentioned that one of the reasons you questioned its credibility was because the data had been collected from pregnant women and you didn't think they could remember, and I find that really insulting to women.

(Applause)

You know, life is really precious, and I believe that that is not an emotional statement. I believe that that is a fact of life. It's so precious indeed that it's really worth working to preserve it and even fighting to improve its quality.

It is our responsibility to work to improve the quality of our lives. I think that this is an endeavor which this panel and the public are embarking upon tonight.

In central Pennsylvania we have been the victims of not only the releases of radioactivity, but also a huge propaganda machine which insists that radiation is not harmful to our health.

GPU Nuclear has an extensive public relations outfit which has set about to convince the public in this area that this water is really almost quite pure and that no matter how it is disposed or, whether it's into the air we breathe or into the water we drink we will not be harmed.

They are wrong. This water is radioactive. We are a population already impacted upon. We need no more exposure from Three Mile Island.

(Applause)

We refuse to select evaporation as a choice. When we are told that we can drink or breathe this radioactivity we feel like prisoners within our own environment.

The truth is there are other alternatives, alternatives which would contain the radioactivity. Only those are acceptable.

(Applause)

This isn't just a political issue as some people think. Rather, it's a life and death situation. We are talking about the quality of our lives.

We and not GPU Nuclear or the NRC must take responsibility to make these decisions about the quality of our own lives and those of our children.

We cannot be cautious enough when making decisions about the release of radioactivity.

Ladies and gentlemen of the panel I urge you to be cautious. I urge you to preserve the quality of our environment to the extent that we are able. I urge you to remember that statistics are numbers and that numbers belong to faces - a young face, an old face, yours and mine.

I urge you to take our message with yours to the NRC that we will not tolerate the evaporation of radioactive waste into our environment.

Thank you.

(Applause)

ARTHUR MORRIS: Ms. Davenport.

NIEL WALD: Mr. Chairman, will you accept a comment or is that out of order?

ARTHUR MORRIS: Go ahead, please if it's brief. Go ahead, Niel.

NIEL WALD: In defense of pregnant women, I was trying to convey without taking enough time to say it that Dr. Stewart's study was a retrospective one in which inquired of these mothers long after the child -- the homes of children who had died anywhere up to 10 years before were visited. So it was a matter of recall of whether it was two films or three films 10 years before, and I think that's a difficult feat for anyone to recall.
[Discussion]

DEBRA DAVENPORT: I just have a few questions and also a few statements of opinion again.

I still don't want the accident water discharged into the river or evaporated into the air.

I also feel that I would like to see it go to Nevada, but I can see that public opinion very strongly favors keeping that water on the island for now.

I feel that the burden has been placed on this population from any emanations from Three Mile Island has been so extensive and so damaging and so tragic that anything else added to this would cause a great loss of life. I also feel that it would add greatly to area grief.

I do question some things about this water. I know that when we were in Annapolis over a year ago listening to an advisory panel meeting there, there was some discussion over the original curies of tritiated water that had been present at the time the accident completed, whenever that was.

What had happened is that apparently we had lost some 700 curies through evaporation. I find that all correspondence that I've gone through shows estimates of tritium to be up at 3,700 curies. Now I find that maybe we are just going to evaporate 1,000 curies and I would hope that the water, should it stay in tanks on the island, would not evaporate excessively, but if it does and it seems to be doing that very well, I don't see why we really need an evaporator which costs $6 to $12 million to evaporate the water.

I feel that it is much better to leave it in tanks, but to truly leave it there.

I also have some questions about whether, and I'm not really an engineer and that's obvious but whether in the engineering sense, the evaporator would work because it is a very large machine and it hooks through the regular evaporating systems once the vapor goes out, from what I understand.

Also, radionuclides and particulate would at least to one percent go past the filters and go out into the environment. Because of this, I'm totally opposed to it, but I'm also wondering, and I would like to ask the NRC, are there any other places in the country that have an evaporator of this size and what sort of operation are they running and what do they use it for.

[Discussion]

Thank you.

I still do have grave questions. I feel that perhaps a machine this large couldn't work over a long period of time and I'm afraid that it wouldn't be temporary and that it might be applied for some other use.

I don't think that necessarily once this accident water would be 'evaporated' that would be all the evaporator would be used for, and I am very, very opposed to any other use for that.

[Discussion]

BETTY TOMPKINS: My name is Betty Tompkins. I just have one observation and perhaps a brief statement.

My observation came from listening to panel members this evening, and I would ask you to very carefully rethink your role. In some cases I thought the panel came across as an adversary and I think at least three panel members seemed to think or the way the questions came across that your main function was to educate the public.

I don't see your role as that. I could be wrong. But my question again is to ask you to very carefully, and this is a very serious matter that we're dealing with, and we are talking about lives of people, to really define for your own information your role.

Ms. Trunk has left I see. I wanted to say to her that people always say not in my backyard -- not in my backyard. But if it's moved from the island, it has to go in somebody's backyard.

So I would urge the panel, and there is a moral imperative here I believe, to think very carefully about the health and safety of we people in central Pennsylvania. It has been said in the past that each generation is responsible for its own time. We are responsible for this time in which we live and we have a responsibility to future generations. We are dealing here, however, scientifically we might think we are, and however much knowledge we might think we have gained over the eight years, and some of us feel that we've gone to college and not gotten any credits, but we are dealing with a lot of unknowns here that will affect the lives of our children and our grandchildren.

I would urge you to vote to keep the water on the island and not to evaporate it.

(At this point in the proceedings Ms. Trunk rejoined the panel.)

May I just say to you, Ms. Anne Trunk, that I heard you say a little while ago that you didn't want it in your backyard. Nobody wants it in their backyard, and if it is not in your backyard and it is moved from the island, it will be in somebody else's backyard with children.

So I would urge you, ma'am, to vote to keep it on the island.

I thank you for your attention.

(Applause)

ANNE TRUNK: Could I make a comment? When this panel started, at one of the first meetings, everybody wanted that water off that island, and everybody from Middletown. So what I'm saying now is just what I remember hearing from you at that point in time.

BETTY TOMPKINS: Ma'am, if you're speaking to me, may I just respond?

ARTHUR MORRIS: Very, very briefly because the idea is not to go back and forth. You had your comment and Ms. Trunk had hers. We can go back and forth on this. Very quickly.

BETTY TOMPKINS: I won't go back and forth. You never heard it from me, ma'am, about evaporating the water or moving it from the island. I have never said that. So I don't want to go back and forth.

I'll just respond while I'm here as to whether people are calling now to make comments about what should happen at Three Mile Island.

You know, I was born in England and I can say this. American people really don't take their freedom that seriously when it comes to speaking out or making decisions, and a lot of American people seem to say, well, you can't fight City Hall or you can't fight the government.

So over these eight years people have said to me keep going but, you know, you can't win because you can't fight City Hall. There are people that are very concerned about this, but they don't speak out. (Applause)

JANE LEE: I'll only take a couple of minutes of your time. I really regard this as an effort in futility, but in view of the seriousness of the proposals that have been made, I just feel that I have to come here. Incidentally, I called a lot of people that I know that are very concerned about Three Mile Island. They are so angry that they can't even talk, much less attend a meeting. They don't trust themselves to attend any meetings or any sessions any more on TMI.

But it seems to me there is a genie in the proposition of creating a nuclear storage site on TMI, and the genie is how long will GPU be able to contain the genie in the storage canisters that will be stored on site?

First GPU was going to clean up the accident. Now we are presented with options which are not really options at all, but rather the less of three evils. How shall we keep the genie in the bottle?

I object to any of the proposals that were made for disposition of the water. I object to boiling it off and sending it into the atmosphere. I object to dumping it in the Susquehanna River and I object to storage on site because I know the performance, the past performance of GPU which is highly unreliable and which has had several leaks in their storage tanks on site.

Any additional releases in this area on this population just heaps additional biological insult to the body. You haven't seen enough evidence yet? Well just go ahead and do this.

And, incidentally, how many people on this board, and I really shouldn't address these questions to you because I don't really blame you for this predicament.

The NRC doesn't live in this area and they plain don't give a damn what happens to us.

(Applause)

And I get the strong feeling that a lot of the members on the board do not either. Some of them don't live in the area and some have saw fit to move their children at far distances out of the area, and I find that highly objectionable.

When the NRC's own rules meet with circumstances which did not exist when the original rules were made, they simply changed the rules. Now don't you remember that they were going to clean up the site and they were going to ship the stuff out and that Three Mile Island couldn't be a storage waste site? It isn't licensed to be a waste storage site, and how dare you store this stuff on that island. How dare you even consider venting this into the atmosphere or dumping it into the drinking water. What kind of people would do this to innocent people? What have we become when we see people in the same room arguing about what we are going to do with this mess when, in either case, they were not responsible for the original mess?

The responsibility for cleaning up that island rests with the people who created the mess through the falsification of leak rates which brought about an accident, and that is the bottom line. They are responsible. And, by the way, I want my name on this. My name is Jane Lee. I wouldn't change places with you people on a bet because you're getting all the static and you're getting all the hostility. I could just weep at what I have seen that has happened to this country. I could weep. I'm 62 years old and I never thought I would live to see the day when my country was just plain going to hell.

(Applause)

Thank you.

TOM BAILEY: My name is Tom Bailey and I'm an attorney here in Dauphin County. I just have a few comments to make to the panel. I realize that we've been through a long evening and I certainly can't understand all the science that has gone before and I don't pretend to.

I would [like] to enter my comments in two words. One is addition and the second is responsibility.

The addition. My perspective is that any addition, meaning additional exposure to radiation is totally out of the question, and I begin with that as a premise that I've seen Bill Travers' presentation rationalizing this EIS. I was at the Lancaster meeting in late January and I saw the presentation, and I had seen it once before.

The presentation that we saw was by a corporation which has direct government support, and you have to see it as a private enterprise for what it is. A private enterprise in this country does not have the right to jeopardize the life and welfare of the people who live in the area. I mean that is the basis.

But the problem is that it is not just the private enterprise - it's the government. If you want to see it as a shamrock or cover, you've got the GPU, you've got the private enterprise and the government is on their side on these issues. The third petal is the public. That's not the way it should be. The third petal should have as much power because the government is to be looking out for the public welfare. That's what it says when you go into the Law Library here in the state, the public welfare.

The public welfare will not be served by any additional exposure.

The second is responsibility. On nuclear plants, the law is very clear on this - federal preemption. The federal preemption is the Nuclear Regulatory Commission. Those are the people you will address and you will speak to. And, again, the word is responsibility. You people are the responsible party to gather public input about this area as to what their feelings are on this issue, and if you aren't sensitive to it, then your whole function has failed.

The responsibility is there. As the woman said before, it's a tough position to be in, but you're there now and you have the responsibility to carry through what you've heard here and tell the people that have the ultimate say that, no central PA does not want any more exposure.

(Applause)

All I would like to say is the burden of proof is on the NRC to prove that these methods of disposal are -- what can you say, they are the best that they can do.

It says in the very beginning of the EIS that none of these alternatives is clearly preferable. Your response should be to the NRC - prove it to us which one is best. It's not my burden to prove to them. They are the ones that are trying to expose it to me. That's the way it is in law, you have a burden of proof, and the burden of proof is on the NRC and they have not met it.

My last comment would be that this is a very new area of the law and you people are on the forefront of setting policy for nuclear responsibility mainly because you're a citizens group. What you do has precedential value that will go for generations.

I wish that you would consult the law and know what it is when you consult the NRC.

Thank you.

(Applause)

ARTHUR MORRIS: Was there another person that wanted an opportunity to comment?

JOYCE CORRADI: My name is Joyce Corradi. I represent Concerned Mothers and Women.

I have a deposition that I will pass out to you after I read a small portion of it.

This is the United States of America, Nuclear Regulatory Commission before the Presiding Board in the Matter of Inquiring into the Three Mile Island Unit 2 Leak Rate Data Falsification.

In a Memorandum of Law filed January 23rd of this year, the numerous employees stated that the administrative and surveillance procedures established by Metropolitan Edison at TMI-2 to fulfill the technical specifications for licensing and operation of the facility were not binding legal requirements of the employees.

I will hand you the rest of that data in a minute.

Now the point must be made clear. This memorandum makes profoundly clear that the employees do not consider themselves bound by the law governing the nuclear facility's license to operate. The question thusly arises how did the employees' attitude toward the NRC's regulations develop, how far up the management ladder does the responsibility for this attitude go, and if management is not responsible, why would this attitude remain with the employees?

Whatever decision is made on this disposal of water, the workers must do the disposing. With the above questions raised, how can you or anyone sitting at this panel be assured that procedures will be followed and safety ensured?

We are again putting the cart before the horse. No matter what is done, the safety of the citizens is at risk. Concerned Mothers and Women find this situation intolerable and want to know what this panel is planning to do about the situation.

In conclusion, I request the NRC staff to show good cause that what I am saying to telling this panel is not a public health and safety hazard.

Thank you.

(Applause)

ARTHUR MORRIS: This gentleman here and then this gentleman will be the last person to come foward.

AL MANIX: My name is Al Manix, Middletown.

I am really dismayed with all the education I see in this room. If you went to buy an automobile, you would give me a better presentation that these people are giving you tonight.

For instance, this device that is going to hurl this water -- certainly the manufacturer has specifications. He will tell you what it will do and what it will not do, how it will do it and what you can't do with it. I haven't heard that.

What are you buying here? What is your interest? Just to set a device out there, any kind? Will you put fans on it or an airplane engine or some damn thing? What are you really buying and what will it really do? How high are you going to put it, throw water up a hundred feet and then let it fall on the ground and go down to the bay or into your drinking water?

These are questions you should be asking. I shouldn't have to ask these questions. You should be sitting here and saying, hey, hold it, we want to know whether it's right or whether it's wrong, and you are not addressing that to me.

So let's find out what this device will do. Who makes it and what will it do and where will the water go? I think there are questions that you should address to these people. We're not dummies.

Thank you.

(Applause)

[Discussion]

FRANK DAVIS: Thank you. My name is Frank Davis.

I'm troubled that we haven't given Ms. Trunk a better answer tonight, those of us who say we are opposed to evaporation of the water or to dumping it into the river.

I will admit that Ms. Trunk probably has heard me say in past years that I was opposed to making Three Mile Island a nuclear waste dump.

What I think in my mind makes a difference now is that even given the GPU record, I think that the water can be stored more safely on the island than it can be unsafely evaporated into the air. And I think that your children will receive less radiation during the years ahead if the water is kept in those stainless steel tanks than if it is deliberately evaporated into the air.

I think that is what changed my mind about keeping the water in the tanks.

Thank you very much.

(Applause)

[Discussion]

ARTHUR MORRIS: Thank you very much.

At this time, I would like to turn to the panel for a discussion, and the first item, unless the panel feels differently, the first item that we said we would attempt to addresss this evening was the EIS.

THOMAS SMITHGALL: Bill, the first question I had, and you've been taken to task on your EIS here tonight calling it sloppy and hastily prepared, is why in the initial EIS draft, why wasn't there more detailed information on the inventory? Why did you just take an overview of it instead of inventorying it, and it took from December of '86 until the end of February before that was even available, at least from where I sit.
[Discussion]
You mean you didn't have that information at the time you issued the initial draft?
[Discussion]
I guess again I've got to question the process. The initial draft is out in December of '86. It comes up to the deadline time for the comment period and then you get the final information, and if it wasn't for the 45-day extension we wouldn't even have an opportunity to even comment on the full inventory of what was there.
[Discussion]

FREDERICK RICE: Bill, is there any pending legislation for low-level waste sites in Pennsylvania or Maryland close by that would reduce the risk of shipment?

THOMAS SMITHGALL: I would like to ask one on that one because it was one of my questions as well. When you reviewed your alternatives for offsite dispersal, was that taken into consideration that you could couple two alternatives of storage on site until there was a closer low-level site as opposed to using shipment to 2,000 miles away?
[Discussion]
And the number of truck accidents is a conservative estimate in itself.

WILLIAM TRAVERS: Yes, it is, in our view.

THOMAS SMITHGALL: So that being the major non-radiological impact is insignificant.
[Discussion]

ARTHUR MORRIS: Anne.

ANNE TRUNK: I just wanted to ask, Tom, if we buried it on site and we wait for Pennsylvania to get a site, how long do we have to wait for it? (Laughter)

THOMAS SMITHGALL: I would like to hear this answer.

THOMAS GERUSKY: First of all, it wouldn't be buried on site. It would be stored on site in tanks until a decision was made at that point to solidify it. Under the Pennsylvania draft proposal there would be no allowance for liquid disposal at the low-level waste site in Pennsylvania. So it would have to be solidified and meet all kinds of special requirements which - I don't know. I'm not sure that because of boron whether it could easily meet the requirements for the site. There may be some other problems associated with it besides radioactivity.

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Your guess is as good as mine as to when we are going to have a low-level waste site. We are supposed to have one by 1993. The legislative process hasn't really started on the implementing legislation yet. So I don't know how long it's going to take.

ARTHUR MORRIS: Niel, I think you had a question or a comment.

NIEL WALD: Yes. I have trouble in understanding the EIS. Given the Table 5.1 which lists the various alternatives and the doses that are associated with them and the costs and the space and so on, I'm having a little trouble with that because it seems with this much information that one might be able to make some choices. Can you explain that opening statement?

[Discussion]

For the 3.5.1 which has zeros in almost every category of cost whether it's dose or accident or dollars, the consideration there, am I correct that the consideration there was that was sort of outside the ground rules of the NRC to allow that?

[Discussion]

Thank you.

FREDERICK RICE: Bill, did I understand Tom to say that we would not be able to store on site solidified?

THOMAS GERUSKY: No, I said it wouldn't be buried on site. It could be stored on site solidified, but I wouldn't suggest that until you know what the requirements for the disposal site are because you couldn't change it then.

FREDERICK RICE: In his proposal he says on site solidification and burial, and then --

THOMAS GERUSKY: It was burial at another location and not in Pennsylvania.

[Discussion]

JOSEPH DiNUNNO: You may have been in receipt of a letter or a note that I sent. I was really raising a question on the ocean dumping alternative largely because I thought some of the statements that were made in the impact statement were not exactly correct, and I wondered if you had addressed that and would you comment on it.

As I indicated, I'm not suggesting that I looked at that and declared that a viable option, but I thought the statements there were misleading and needed to be corrected.

[Discussion]

My only concern and the reason for flagging this is I find it confusing to all and particularly to the public when we say it's perfectly all right to dump this into the Susquehanna River, but the same Federal Government is saying but don't put it in the ocean.

Now that's a contradiction that confuses some of us.

WILLIAM TRAVERS: There are many of those, and the reason -- I'll just restate the reason we didn't consider it further was not on a technical basis but more on an administrative --

JOSEPH DiNUNNO: I understand and I think it's important to bring that out.

WILLIAM TRAVERS: As a matter of fact, I would say without having done the calculations that if we were to do them given the source term involved in this water that there would be no significant environmental impact associated with dumping the entire water --

JOSEPH DiNUNNO: Well, I would think it would be much less than putting it in the Susquehanna River except for the transportation problem which you haven't addressed because obviously you have to transport it to a place where you could accomplish that. But it was making sure that you clarified your position so that you don't imply that that wouldn't be a safe thing to do.

ARTHUR MORRIS: Tom.

THOMAS SMITHGALL: By not giving any okay to any specific alternative, haven't you tacitly given the okay for evaporation?
[Discussion]
So when it's all said and done here, Bill, and let's cut through all that, and when it's all said and done and you're ready to send your recommendation up to the Commission it's going to be evaporated.
[Discussion]
Well, I just wonder what we're all going here quite honestly. I mean are we playing a little game here?
(Applause)
Are we going to have any impact on what is actually going to be sent from the staff or [are] we just going to be part of a document that is then going to gather dust after you've done the process that you're going to allow happen anyway? That's my problem with this whole process, Bill. I know you're going to collect our comments, but then you're going to send up the proposal that is already on the table by the licensee, and it appears, regardless of the law and regardless of what you say, it appears that the decision has been made by you've tacitly given an okay because you've said all the alternatives are acceptable. You haven't even prioritized them other than the fact that you give ranges of costs and ranges of doses.
[Discussion]
I'm not going to change his point of view on it. I'm asking about the process and we have people ask about the process here that are concerned about it. We're sort of taking the heat here, and I want it understood where we are on this. Are we just going to go through the exercise or is this going to be heard? Are the concerns of the people here going to be heard? If it's a 12 to nothing vote or a 6 to 5 vote, what kind of an effect is that going to have on the final outcome?

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WILLIAM TRAVERS: I think it's important, and you know it better than I, that the panel was formed by the Commissioners. They don't advise the staff. We come to provide as much information as we possibly can to you and you advise the Commission. I don't know how much more clear I can be on the process.

ARTHUR MORRIS: Quite frankly, that's what we need to make a determination on tonight at this time. We need to make a determination whether we have concerns about the EIS that have not been addressed or whether there is support for it or whether there is no comment on it from the panel, or a combination of the above.

I understand what Tom is expressing here, but beyond that the panel I feel has to at least address it in some fashion and it may choose to address it by telling the Commission that we have no comment. That I'm sure is possible.

THOMAS SMITHGALL: Let me just sum it up and then I'll leave it after this.

ARTHUR MORRIS: I think that comes under the next discussion.

THOMAS SMITHGALL: No, I think it's important to hear about the EIS and it's the process that's being done. We are probably on unchartered waters any way with an environmental impact statement on a license amendment. Maybe I'm wrong in the process here.

WILLIAM TRAVERS: It's probably relatively rare, you're probably right.

THOMAS SMITHGALL: Okay. So my point is you've taken 10 alternatives and said none of them are preferable over the other, and the licensee six months earlier has put one on the table that in essence you've said is okay. I mean how do you not say no to that? How could you not say no to that? Even though you go through the motions and you go through the law, you get to the same answer.

WILLIAM TRAVERS: That's what I have to do. If I don't do it, I'm going to be called to question for it and I should be, and that's what I'm going to do.

THOMAS SMITHGALL: Talk to the people out here and ask them whether or not they feel the decision has already been made or not.

ARTHUR MORRIS: We're involved in a discussion here that involves a staff responsibility and a separate one that involves a Commission responsibility. The staff under law is required to look and consider things under certain regulations, which they are telling us they have indeed done. When they consider the regulations and their guidelines, they look at the options and within certain parameters they feel that they are comparable.

You may disagree with that as an individual, but they are saying from a technical staff point that is their comment.

THOMAS SMITHGALL: Fine.

ARTHUR MORRIS: What I hear Bill saying is the Commissioners can consider other types of things, but staff should not do that.
I understand again the frustration Tom's offering and I think that will come with whatever the Commission ends up doing with what this panel would recommend.

THOMAS SMITHGALL: Will you finally make a recommendation to the Commission?

WILLIAM TRAVERS: I intend to make a recommendation, and I've said that many times.

ARTHUR MORRIS: We've been told that on numerous occasions that you would at some point make a recommendation.

JOSEPH DiNUNNO: Isn't it true, however, that the Commission is restrained as to the conditions under which they also make a determination without a public health and safety problem and without an environmental impact? These are the two laws under which they are acting.

WILLIAM TRAVERS: That's a good question and I've asked that same one.

JOSEPH DiNUNNO: So if there is no impact and if there is no public health and safety, then do they have any option but to approve the proposal that has been put on before them?

WILLIAM TRAVERS: Do they have the option? I think they do. I'm not a lawyer, but I'll tell you what I think. There is language in the regulations that implement the Atomic Energy Act which speak to the public interests and it's a rather vague term, but I think based on that fact there is some latitude on what the Commission can and can't do.

JOSEPH DiNUNNO: I think that is what Tom is struggling with. We will be presenting the views as we've heard here in the last few days, but are they for naught because they could not confirm that there is an impact and they cannot confirm that there is a public health and safety problem. So are we whistling in the wind?

WILLIAM TRAVERS: I don't think that's what I heard, but I think the answer to that is the Commission does have discretion. They don't have to take what we say certainly.

ARTHUR MORRIS: Does anybody on the panel at this point want to offer comments or suggestions on a course of action that the panel should take regarding the EIS?
Yes, Mr. Rice.

FREDERICK RICE: Well, as a County Chairman of Dauphin County and also as a member of the panel I have to wear two hats. I do not believe that we've reached a comfort zone for the action of the evaporation, nor have we had

guarantees of 100 percent safety for our citizens.
Therefore, I cannot support the evaporation.

ARTHUR MORRIS: Fred, excuse me, are you going to speak first to the EIS? That's what's before us.

FREDERICK RICE: I accept that.

ARTHUR MORRIS: Okay.

FREDERICK RICE: Except for one point.

ARTHUR MORRIS: I guess I'm trying to get a flavor, and maybe the wrong way to do it is the way I'm suggesting we do it.
Niel, go ahead.

NIEL WALD: Why don't you define the second step so that we all know, because that may be where Fred's comment comes in.

ARTHUR MORRIS: Okay. There are two steps that I mentioned at the last meeting and again tonight.
One is that there is a document that has been completed here as a draft called the Environmental Impact Statement that contains several alternatives that they have commented on. I would like us to offer some comment on that, whatever it is.
Then the next step after that, there is a specific proposal by GPU on the evaporation alternative, and I would to, as a separate item, after we have taken action on this, speak to that issue and say, one, are we supportive, two, are we not supportive and I mean try to generate some position on that so that we can speak to the general parameters of the EIS and the specific recommendation of evaporation.
That's what I'm trying to us to at least accomplish tonight in some way, shape or form.

FREDERICK RICE: All right, I'll comment on the EIS.

ARTHUR MORRIS: That's what I thought you were jumping ahead on, Fred. I'm just trying to keep us on track here.
If anybody disagrees with the procedure, let me know, but we've got to try to -- at least I would like somebody to offer a comment or a suggestion on the EIS at this point.

FREDERICK RICE: Well, I think it's very acceptable to me, except for the low-level disposal sites that possibly could be here in the East close-by. That could have been included, and other than that I accept it.
That's my comment.

ARTHUR MORRIS: Okay. Is anybody in a position who would like to make a specific motion on it to get it on the floor so that we can then discuss that particular motion and either agree with it or disagree with it.

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(Pause)
Do you want to take a break and draft up some words or what?
(Laughter)
(Pause for off-the-record discussion among the panel members)
Are you going to put this in the form of a motion, Fred?

FREDERICK RICE: Yes. I would make a motion that it's an acceptable environmental impact statement with the exception that it should have included a low-level waste disposal site, a deposal site in the East, a study of that.

ARTHUR MORRIS: Okay. It's been moved that we state that this is an acceptable EIS with the proviso that they should have looked at closer disposal sites?

FREDERICK RICE: Yes.

ARTHUR MORRIS: Is that what you're saying?

FREDERICK RICE: Yes, low level and close.

NIEL WALD: Can I ask a question for clarification?

ARTHUR MORRIS: Yes.

NIEL WALD: By closer disposal site, are you suggesting that they should have considered the possibility of storage pending disposal sites in Pennsylvania?

FREDERICK RICE: Yes.

ARTHUR MORRIS: Do we have a second to that motion?

MICHAEL MASNIK: Could you restate the motion?

ARTHUR MORRIS: The motion as I understand it is that we as a panel state to the NRC Commissioners that we find this to be an acceptable environmental impact statement with the condition that we felt that the EIS should have dealt with possible options of a low-level waste disposal at sites within Pennsylvania. Realizing that they are not now in place, but it should have at least considered the potential for those sites at some point in the future. That's what I hear I think he said.
But I haven't heard a second to the motion.

JOHN LEUTZELSCHWAB: I second it.

ARTHUR MORRIS: It has been seconded. So it's before us for debate or discussion.

JOSEPH DiNUNNO: I have a question of the proposer over there. I'm having some trouble seeing where that would take you other than the transportation statistics. Will it change anything?
What are you trying to achieve by that? I guess I don't understand.

THOMAS SMITHGALL: I see it as two parts. I think what Fred is trying to get on the table is whether we feel this is an acceptable EIS period. He wants to have some additional information and comment on that that it take into consideration the possible future disposal of this water, either solid or however, within a shorter distance, such that the traffic fatalities would be less.
So I think there are two parts to that. So I have a problem of voting either way on that one, because it's got a yes and no to it. I would rather break it out.
Art, I think what you're trying to get at is whether we feel it's an acceptable EIS, am I not correct? Is that what we are trying to get to here on this?

ARTHUR MORRIS: I'm trying to get to that, but there may be conditions that make it acceptable to people, and then if that's the case, then they can add those conditions, and that's why they voted for it with those conditions.
I would suggest, however, in order to make it easier for us that it may be better for us to consider the conditions first and vote on them and then vote with them attached to the acceptability of the EIS.
We've had one condition that has been suggested here. It may be easier for us to vote on those conditions up or down as they come forward in order for us to get to the issue.
Does anybody have a comment at least on the condition that has been added to this?
Tom, maybe you want to offer a comment and speak to it, or not speak to it?
(Laughter)

THOMAS GERUSKY: No, I don't have any comment. I wouldn't know what to say.
I mean the issue -- I don't think it's important from the standpoint of the impacts at all. I think it's important from the standpoint of what's done with the water on the island, and there is a little bit of difference between that and the impacts.
I think the environmental impact statement, even though it has raised a lot of concerns and debate about biological facts and about offsite doses and so forth, and about the actual water, the contents of the water, in the context in which the NRC had to put this thing together, I can't find fault with it as a document.
I'm very concerned though about what our role is going to be in the actual license application review process which I think is much more critical to the issue because we don't have enough facts to make that decision yet, and I don't see those facts coming out shortly.
We still don't know what kind of a facility they are planning. I mean it's a very very general proposal that's been submitted and that's what my concern is. Here we're talking about a generic or almost -- it's

something we've asked for for a long time and they finally came up with about the same time that GPU proposed to dispose of it in a specific way. None of the options are bad.
[Discussion]
But will the -- excuse me -- will the license application by GPU provide that information? If not, I think the license application, the amendment that is going to be required, or their proposal, I think the system is faulty if it doesn't contain that.

WILLIAM TRAVERS: Why is that?

THOMAS GERUSKY: Because there should be a public document about exactly what they are going to do.
[Discussion]
But a tech spec change is going to be required.

WILLIAM TRAVERS: That's correct.

THOMAS GERUSKY: So they have to submit a proposal for a tech spec change.

WILLIAM TRAVERS: And that's been done and you have a copy of it.

THOMAS GERUSKY: But it's not detailed enough. I don't know how you can react to that. That's my concern.

WILLIAM TRAVERS: What conditional detail do you think --

THOMAS GERUSKY: You don't even know what the final design of the system is.

WILLIAM TRAVERS: We've scoped out an evaporation process, among a number of alternatives.

THOMAS GERUSKY: What are we talking about? We're not talking about this now. We're talking about the license, the actual change in the license. This is a separate document. This is to look at the generic disposal of that water on the island.
Now they come in with a license application for a specific proposal and what do you do?

WILLIAM TRAVERS: No, that's not what has happened if you take a look at the proposal.

THOMAS GERUSKY: All right. They've come in and asked that the restriction be lifted and they do propose a specific proposal as part of the package.

WILLIAM TRAVERS: No. What has been proposed is to remove a prohibition that currently stands in the license that you cannot dispose by any means the processed water. The package merely says that given the radionuclide content of the water, that prohibition should not bind us. It references their proposal for an evaporator process and you've got that as well, but it doesn't give you the details of the system. It merely gives you the assumptions under which they've run in estimating the releases of effluents, and in fact it's the same set of assumptions that we've used in our environmental impact statement.

THOMAS GERUSKY: But they do not have an evaporation system on the island now.

WILLIAM TRAVERS: That's correct.

THOMAS GERUSKY: So there is a significant change in their waste treatment process. They don't have to submit any additional proposals formally to the Commission.

WILLIAM TRAVERS: They have to submit a safety evaluation report.

THOMAS GERUSKY: And procedures, and that's a public document which will be reviewed prior to your decision on this?

WILLIAM TRAVERS: Yes. Maybe I'm not following you, but it is not in connection with the formal licensing amendment process. That's the difference. The license that GPU has is probably as unique as any you'll find, and this particular statement that is contained in their license is probably the strangest thing you'll ever see in a license.
It was put in place when the Commission said, when we issued our 1981 PEIS, that we reserve the right for the Commission to approve some disposal technique. So the staff noting that the Commission issued this policy statement went into the license that said you cannot by license condition dispose of accident generated water.
Now you might think that once the Commission approves some method of disposal that that would go away. It doesn't, unfortunately.

ARTHUR MORRIS: Bill, please. We're discussing the EIS first, and we've gone back into -- I mean I think the question really is when we get to the evaporation option, the question is is there an opportunity for the public and other people to comment on the specific kind of equipment that will be used.
I'm not looking for an answer now.

WILLIAM TRAVERS: Okay, fine.

ARTHUR MORRIS: And what is the tool that would be used for that opportunity, if indeed it exists.
Now in order to try to simplify this a little bit, Tom Smithgall suggested before and I disagreed with him, but I think he's absolutely right, I think what we should have before us, and I hope that Fred and the mover would agree to allow this to happen, is we should have before us a motion that the EIS is acceptable period.
Then if he wants to add a condition on that, we can vote up or down on the condition, and I think we're going to make a lot of more sense out of this.
So if the mover and the seconder would agree to that position.

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FREDERICK RICE: I agree.

JOHN LEUTZELSCHWAB: (Nodding affirmatively.)

ARTHUR MORRIS: Then what we have before us is a motion that says that the EIS is acceptable, is an acceptable EIS.
Now if somebody wants to try to amend that, then please make a motion and we'll get a second and then we will vote up or down on the amendment, and then we'll move for a vote on the question of whether it's acceptable or not to the panel.
Elizabeth.

ELIZABETH MARSHALL: I don't have an amendment, but I do have a question. During the testimony that we received tonight there was a letter from it sounded like Dr. Kaku commenting on the environmental impact statement, and he commented on it rather negatively.

ARTHUR MORRIS: He said that were were omissions, that there were discrepancies and there was sloppiness. I wondered if anyone on the panel had that impression, and many of you deal with environmental impact statements more than I do, or if you, Mr. Travers, had any reaction to that criticism.
[Discussion]
Is there a member of the panel who reacted to that in any particular way? How about you, Tom?
(Laughter)

THOMAS GERUSKY: Oh, I think any body can be critical of a lot of the portions of the document, but I think when you look at it in the terms that it was proposed and in comparison to other environmental impact statements that we have seen, this is a good one. I mean it looked at as many options as possible and they followed their procedures.
The couple of items which, unfortunately, they can't take into consideration really are public sentiment and other impacts other than radiation impacts and that they can't do. So it's kind of a limited document itself.

JOSEPH DiNUNNO: And I can comment on that also. I've prepared a lot of these in my time, and I looked at this and I considered it as sort of a bounding document.

ELIZABETH MARSHALL: A what?

JOSEPH DiNUNNO: What is called in business a bounding document. You develop parameters and assumptions that give you the outer bounds of what you would expect, and that allows for uncertainty in the assumptions that you make.
For example, a one percent carryover of water as you evaporate that off, that was an assumption that is made and it gives you a term that you can deal with. Dr. Travers doesn't know whether that is 1 percent or 1.2 percent or 5/10th of a percent. Those specifications still have to

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be developed. But that gives you a number that you can work with that really bounds the results that you get. So it's a bounding type calculation. It's very conservative and very reasonable in that sense.

WILLIAM TRAVERS: I think one percent is probably conservative based on what we know about evaporation.

JOSEPH DiNUNNO: That's the point I wanted to make.

ARTHUR MORRIS: Does any other panel member have a comment on the motion that is before us at this time?
(No response)
Hearing none, I'm going to indicate what the motion is and then ask you to vote up or down on it.
Basically the motion is that we tell the Commissioners, and I assume in a letter from the Chairman, that we feel that the environmental impact statement is an acceptable document.
All those in favor of that motion signify by saying Aye.
(Chorus of Ayes)
Opposed.
(Chorus of Noes)
Does anybody want a specific tally of the Yeas and Nays? Does any panel member want to see a tally of it specifically?

FREDERICK RICE: Aye.

ARTHUR MORRIS: You do?

FREDERICK RICE: (Nodding affirmatively)

ARTHUR MORRIS: Okay. All of those in favor of the motion please signify by raising one of your hands.
(Show of hands)
All those opposed so do it.
(Show of hands)
(Applause)
I assume that the public is clapping in response to the approval of the EIS by a count of eight to two.
Let the record show that I'm joking when I say that, but that's what one would expect if you're clapping for the motion. But it was an eight to two vote in favor of the motion.
The second item that we have before us again is the specific option of evaporation put forward by GPU, and I sense that that is the one that probably people are particularly sitting on the edges of their chairs to get the panel's reaction on it.
Again, I'm open for a motion on that. Again it can be a motion to approve it or deny it or to suggest no comment which I would hope we would not do, that we would at least take a position Yea or Nay on it for whatever reason you want to.
So I would look for at least some form of a motion to put it before us.

FREDERICK RICE: I make a motion that we disapprove it.

ARTHUR MORRIS: You make a motion that we recommend to the NRC that they not approve the evaporation option?

FREDERICK RICE: Correct.

THOMAS SMITHGALL: Second.

ARTHUR MORRIS: We have a second to that motion.
Comment on the motion?
(No response)

FREDERICK RICE: Can we give our alternative after the vote?

ARTHUR MORRIS: I think it would be in the public's interest to hear your comment at this time on what your position is quite frankly. If you are opposed to it I think maybe you have some responsibility as a panel member to state why you're opposed to it and if you support it maybe the same thing. Now is the time to express an opinion on it.

JOSEPH DiNUNNO: I'll make a comment, or I dare make a comment. We were admonished this evening to make sure that we look at our role up here, and I took that seriously. I thought that was a very, very important comment.

So I asked myself the question what is our role and what is my role, and I think I have two roles. The most important one I think is to review the views that we've heard and the expression of the community because that's our fundamental thing. That's one thing.

And the second, I owe it to them to also give them my views. So there are two parts. I'm reacting to what I hear, but I have to react from a technical standpoint. That's the basis from which I come. So I have to be honest with myself and them, too.

So I think we have to go forward to the NRC with something which maybe isn't an endorsement totally and wholeheartedly of everybody involved in this process of this option which has been given, but I think we have to lay it out the way it is.

The way I see it is that from the public testimony that we have received I'm having trouble sorting out, because I heard different things. I heard keep it on site and don't do anything with it and ship it off site. So I don't see any consensus from what I hear out there, and I'm not sure how I would represent the public view.

So I would have to say that there is no consensus that I heard out there of any one option that is totally acceptable as far as I can see. There are some strong opinions as expressed in a variety of ways.

So I don't really know how to characterize that other than a diversity of opinions and a variety of opinions.

On the technical side of the thing I would honestly have to say I see no technical reasons, even hearing the arguments this evening which were quite adverse in some ways, but balancing that against what is in the impact statement and the other more positive statements that have come in

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from other authorities in this field, I would have to say technically I see no reason for objecting to this particular option.
So there are two things, a public view which we have to represent, and my own position is that technically I see no basis for objecting to this alternative as being an unsafe thing.

ARTHUR MORRIS: Any other panel member who would like to speak at this time on the motion?
Joel.

JOEL ROTH: I basically will disagree with my panel member to my right. I think overwhelmingly we heard, with the exception I think of one person who said they want to keep it on site, or at least that is what I was hearing. I think that was a pretty good assessment in fact.
At the last meeting I was asked to compile some of the reflections of what we had heard, and I thought that the three organizations, SVA, TMIA and LEAF were pretty clear on being opposed to dumping into the river and evaporation.
And again overwhelming, and overwhelmingly can mean 10 to 2 or whatever, but certainly I don't think it was 6 to 4 to remain in the tanks on the island until more studies were done and maybe more reasonable methods are determined. There is no rush to do it now.
There was a large concern heard tonight about tritium. Again, a very strong distrust as I heard again tonight of GPU, a strong concern about the cumulative effects of radiation exposure and, lastly and certainly not least important, is the added stress to the residents of the area. I think that definitely must be considered at all costs, that the stress has to be considered regardless of whether an EIS can take that into consideration or not.
Then, lastly, the one thing that really had me very concerned and a little angry, and I'm sorry Frank Standerfer left at about 5 after 6 tonight, in a February 26th meeting in Lancaster the Mayor here was talking about, and I'm quoting from the transcript, "You're saying that if you wait that long a period of time the potential is that you start running into tankage problems," talking about the water on the island, "and you'll need some replacements. Is that what I hear?" And Mr. Standerfer replied, "Certainly the maintenance activity which we would prefer not to have custody of." The prime person who caused it does not wish to have the responsibility, and that is just abhorrent to me and I just can't go any further at this point.
I'm against it.
(Applause)

ARTHUR MORRIS: For the record I should indicate that Mr. Standerfer did call me and indicate that he would have problems making the meeting this evening because of another engagement he had and that there would be other staff here to speak to the issue.
He did let the Chair know. I just wanted you to know that. He was concerned that he couldn't make it.

FREDERICK RICE: He was here earlier.

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ARTHUR MORRIS: Yes, but I'm just clearing up the air that he did mention it and called me and he was concerned that he would have to leave early and he told me that.
Tom.

THOMAS SMITHGALL: Whether or not we agree with the BEIR Report or whether or not we agree with the cancer statistics we've heard, I think what we really have at hand is more of a moral issue, a political issue and an emotional issue that is about as basic as we can get. Our families, our children, our quality of life, we've heard all the comments here tonight. I think it's time that we go beyond that expert testimony and heed some of the warnings and the cautions that we've heard here tonight. If we don't do that, I think we are remiss in what Joe has commented on as our responsibility to reflect the comments of the people here in South Central Pennsylvania and here in Harrisburg.
I think we should opt to prevent any further intentional releases to the environment either by dumping or by evaporation.
I think we heard in Lancaster that enough is enough and I think we have heard here tonight that enough is enough.
So I am against the evaporation process.

FREDERICK RICE: Or the dumping into the river.

THOMAS SMITHGALL: Or the dumping into the river.
(Applause)

ARTHUR MORRIS: Mr. Rice.

FREDERICK RICE: Since I made the negative recommendation, I would like to comment that I'm concerned about the 2 million 300 thousand people in Central Pennsylvania who have expressed an endured with the risk that seems very indefinite at this time. Therefore, I would support retaining it on the island until a deep site repository low-level waste site could be identified and the water solidified even now, and then shipped to this deep site repository somewhere in Pennsylvania or Maryland, somewhere in the east to keep the exposure of risk and accidents down.
(Applause)

ARTHUR MORRIS: Anybody else on the panel that would like to make a comment that hasn't at this point yet?
Tom, let's give everybody a change.

ELIZABETH MARSHALL: I think that I echo a lot of the comments that have been made by the panel. I would like to say that I think there are well intentioned people on both sides of this issue and are trying to resolve a problem with our technology in this century has brought to us. But we can't have faith in technology. We have had the accident at Three Mile Island, for example, and we have had a space shuttle explode. There have been many dramatic illustrations of the fallibility of technology.
So I would agree that to evaporate the water or to discharge it into the Susquehanna would not be the wise thing in the public's interest at this

time, and that some of the other alternatives that have been mentioned might present a better solution to this problem in the future.

So I would not be in favor of supporting evaporation.

(Applause)

ARTHUR MORRIS: Niel.

NIEL WALD: I've heard all the discussion. I'm on this panel as one of the more technical people rather than a local resident, and I think I'm in the same boat as Joe DiNunno is.

From a technical standpoint I do not see any convincing evidence that there is a hazard to health from radiation effect itself that will be of significance to the population.

On the other hand, I'm impressed by the degree of concern that has been shown by many of the people, some of whom represent not only themselves, but organizations.

To counterbalance this concern, and let me just for a moment go back to the krypton-85 situation where it was impossible to proceed with any cleanup without venting or getting rid of the krypton 85. The venting was the least costly in terms of radiation exposure compared to some of the alternatives.

A case was made, it seems to me satisfactorily, that the venting was therefore justified and a major educational effort went into explaining to the public, and I know I participated in explaining to my medical colleagues in this area, just what was going on and why.

I haven't heard a case being made for the need to go ahead with the disposal by evaporation. I see no technical reason why that might not be satisfactory. It's been done in other similar situations.

On the other hand, with the degree of public concern it seems to me that a case needs to be made to explain why this should be done at this time, and I really haven't heard that from the people who made the proposal.

On that basis and considering the health impacts from the standpoint of psychic stress which I know that the NRC is not allowed to consider by court decision, as a physician I am concerned about it.

I would therefore vote against the evaporation at this time.

(Applause)

ARTHUR MORRIS: John.

JOHN LEUTZELSCHWAB: I guess I'm the one person who is a technical person that lives right next to the power plant. Technically I see no difference in the options. I think I agree with all of the other technical people on the panel.

I guess as somebody who lives near the plant, the question is do we want to get rid of it right now and take care of it or let it hang around for a while and take care of it later. I'm sort of opposed to putting things off until later because it doesn't get any better other than the fact that the tritium will decrease of course over the years.

I'm not sure how I would vote on this. Maybe I'll abstain. I sort of favor getting it off the island. I think there is a need to do that. Putting it off until later just puts the problem off until later, too.

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The stress will continue. It's like pulling off a Band-Aid. You can pull it off quickly rather than over a long period of time.
So I guess I'm on the fence.

ARTHUR MORRIS: Anne.

ANNE TRUNK: I'm going to go along with John. I'm kind of on the fence. I've been hearing people say take it off the island and keep it on the island. I would like to see it off the island. I've always said that, and I'll stick to that.
So I'm going to go along with John. I'm on the fence.

THOMAS SMITHGALL: Can I ask a question?

ARTHUR MORRIS: Well, I think --

THOMAS SMITHGALL: No!
(Laughter)

ARTHUR MORRIS: No, because I think it's appropriate for the panel members to offer comment directly without having to respond to questions at this point.
The chair is going to offer a comment. You're the only other person besides myself that hasn't. Do you choose not to?

THOMAS GERUSKY: Okay. Unless somebody would disagree with the Chair offering a comment, I will do that.
Normally the Chair does not necessarily make comments on a situation like this, but since it's been something we've all deliberated on so much and why we're here tonight, I think it's important that I do.
First, I don't think, although we've heard a lot of comments tonight on the national standards, I do not feel that this is a forum for us to discuss those aspects. They exist in law and there is not much this panel can do about them even though we've heard comments directed at them.
I think what Eric Epstein had to say about the public has not shown really necessarily, although he solicited comments, has not shown directly an awful lot of interest. There is a lot of apathy. I don't have any doubts about that. There is certainly in Lancaster.
I do not see the interest or the concern. I've heard it from people from Lancaster who have attended meetings and they've come to several of the meetings and they've spoken out very strongly, several people have. But generally there has not been in my community a comment or concern expressed to me.
I held a town meeting on Monday night and there was no comment at all on this issue, none whatsoever, with the issue coming up. Letters? No letter of any kind. If I've gotten one or two, I don't recall it. I have had a lot of calls from Francis Skolnick and I've talked to her back and forth, but there has not been a lot of public concern in the Lancaster area on this particular issue.

There has been comment made about the fact that the public or certain members of the public don't trust GPU to evaporate. My feeling on that is if they don't trust them to evaporate, then why do they trust them to manage the water on the island?

It does appear from listening to the public, and I sense that there was a fair amount consensus. There was a couple of people that said -- one person said you shouldn't do anything. You shouldn't hold it on the island and you shouldn't evaporate it and you shouldn't dump it. You shouldn't do anything, but don't put it in the atmosphere. That is just not practical. You've got to do something even if it's holding it on the island.

Another person at the last meeting indicated that they didn't want it held on the island, and tonight gave mixed reaction to it.

But besides those two people, I think generally what I've read from testimony is that it should be held on the island from the public I've heard.

My personal feeling is that's wrong, and I publicly state that. I don't think this problem is going to go away. It's always going to be that water in those tanks on that island, and if it's addressed ten years from now it's going to be the same question.

I don't believe that the public are going to come forward, the same members that are here tonight or similar members with similar points of view are going to come forward and endorse an option at that point either. That's my feeling. I could be wrong, but that's my honest feeling on it.

I just personally feel no reason why this panel should offer opposition to the evaporation process. I do not feel that we should and that's my opinion. I accept my responsibility as a public official. I've listened to the technical people and I've listened to the public, and I feel I need to make a statement this evening on the issue.

With that, everybody has had a chance to speak their piece on the panel and I personally feel it is time for us to vote.

The motion is to recommend to the NRC that they should not approve the evaporation option. That's what is before us. A yes vote is for that action. If you vote yes it means basically you don't evaporate. If you vote no it means you're opposed to that motion.

I'm going to really just make it easy and ask everybody to raise their hands that would vote yes on that motion now.

(Show of hands)

I see one, two, three, four, five hands on the motion.

Those people raise their hands that are opposed to that motion

(Show of hands)

One, two, three four hands and one abstention.

So the motion passes by four to one.

(Applause)

Beyond that, are there other comments that the panel members would like to offer?

(No response)

I asked if Joel Roth would give a sense of the concern of the public that was expressed at the last meeting and he indicated he feels his comments that he offered here earlier on and maybe he could go through them and --

THOMAS GERUSKY: I just don't understand what we do next now. I don't have a problem with saying no, but we have got to then say what we would recommend be done and we haven't done that.

ARTHUR MORRIS: Well, let's hear it.

THOMAS GERUSKY: I just don't think that we ought to just forget about it and go down to Washington and say no and not come up with ---

ARTHUR MORRIS: I'm not suggesting that. I said that we have to now determine what other comments we would like to make, and if one of them is offer other suggestions, then that is what the panel should feel free to do. It's pretty clear to me at this point, and maybe we can take a vote on it, and maybe somebody wanted to offer a comment that the water should be held on the island because that is one of the things I sense from at least most of the people that voted for this option that at least at this time the water should be held on the island.
If that's what you're looking for, I think maybe that kind of motion would be in order to say that it shouldn't be evaporated and for the time being until a future time, whatever the person might want to suggest, it should be held in the tanks.
I think that's the direction.

THOMAS GERUSKY: Yes, it is.

NIEL WALD: That would be the way it is now, right?

ARTHUR MORRIS: Well, no. I mean all we've said is that we oppose evaporation. We have not said anything about what they should do with it. Now we can choose to sit back and do nothing or we can choose to offer a comment on what they should do with it.

NIEL WALD: I tried to explain the basis for my vote which is at the time time the case has not been made convincingly for taking the action of evaporation now, and I'm glad you added at this time in one of your rephrasings of this.
I think that is something that we can reflect by an obviously split vote, but that is the option to maintain the status quo until there is a further basis for consideration of any of these options or a better one.

ARTHUR MORRIS: I think to reflect that though it must be put in the form of a motion and must be carried. I don't think we can interpret the previous action to indicate that it's a status quo option. It is an opposition of the alternative recommended.
I sense what you're saying is right, but I think we've got to vote on that. So if you want to put it forward, you make the motion that the sense of the panel is you're saying to maintain the status quo until --

NIEL WALD: Until a stronger case is made for taking the proposed action at this time or until there is a more desirable alternative.

ARTHUR MORRIS: What I have down here is to maintain the status quo until a stronger case can be made for a more desirable alternative.

NIEL WALD: For the proposed option or a more desirable alternative.

ARTHUR MORRIS: To maintain the status quo or a different option to that is how I read it, and the option can be anything including the evaporation.

NIEL WALD: Including the evaporation. That's what I meant to include, yes.

THOMAS GERUSKY: I'll second that.

ARTHUR MORRIS: It's been move and seconded that we maintain the status quo until a stronger case can be made for a more desirable alternative, and more desirable again could include evaporation.

NEIL WALD: You had better specify that because when you say more desirable it seems to be ruling out evaporation which I don't mean to do.

ELIZABETH MARSHALL: I think that Niel said for evaporation or a more desirable alternative.

ARTHUR MORRIS: How about if we say if a case can be made for a more desirable alternative including evaporation?

NIEL WALD: I don't think that says it.

ARTHUR MORRIS: Okay. Rephrase it. Say it.

NIEL WALD: Until a stronger case can be made for evaporation or a more desirable alternative.

ELIZABETH MARSHALL: I think you should be the word "either" in there, either evaporation or a more desirable alternative.

THOMAS SMITHGALL: Why don't you read what we just voted on. We voted on it, didn't we?

ARTHUR MORRIS: There was a motion made, and the motion that was made was to oppose the evaporation option. That is what I wrote down and read several times.

THOMAS SMITHGALL: And how we're putting it back in in another option.

ARTHUR MORRIS: Well, no, no. The motion before us now that has been moved by Niel and seconded by Tom Gerusky with a friendly amendment, as I understand it, is to maintain the status quo, this is the motion, until a stronger case can be made for evaporation or a more desirable alternative. That's what it is. The key part of the motion is to maintain the status quo. There is a condition on that however.

NIEL WALD: If the sense of the previous motion was forever ban evaporation, I would have to withdraw my vote because I didn't mean that. I meant now, evaporation now I voted against. I think that was the sense of the motion really and not forever.

MICHAEL MASNIK: Could you also say to make a stronger case to take action? Is that a fair characterization?

NIEL WALD: That's what I'm trying to convey, yes.

MICHAEL MASNIK: And then may be you could drop that whole last part of it.

ARTHUR MORRIS: Wait a minute. Let me understand what you're saying here. We only really want input other than the panel just for clarification. So if this is a clarification question, go ahead.
It's maintain the status quo until a stronger case can be made --

MICHAEL MASNIK: To take action.

ARTHUR MORRIS: Until a stronger case can be made for evaporation is how it reads.
Now if Niel wants to amend that, and I'm not sure I really --

NIEL WALD: For evaporation or --

ARTHUR MORRIS: Until a stronger case can be made for evaporation or a more desirable alternative is what the wording is.

NIEL WALD: I would be willing to modify a desirable case to take action including --

ARTHUR MORRIS: Go slowly. Until a stronger case can be made is what I have. If you change that to something else, go ahead. Go slowly.

NIEL WALD: I'm having trouble because it's in the air instead of in front of me. A strong case can be made for I would say definitive action including -- then go on with the evaporation or a more --

ARTHUR MORRIS: Okay. Maintain the status quo until a stronger case can be made for definitive action, including evaporation or a more desirable alternative?

NIEL WALD: Yes.

ARTHUR MORRIS: It has been moved and seconded in a very friendly way that the motion, and unless one of the two motioners would disagree, then we would debate that, but they don't, and this is what they've said at this point.

Maintain the status quo until a stronger case can be made for definitive action, including evaporation or a more desirable alternative.

JOSEPH DiNUNNO: May I make a comment?

ARTHUR MORRIS: Certainly.

JOSEPH DiNUNNO: It sounds more confusing than it has to be. I was under the impression that what you're trying to say is there was no case made for doing anything at this stage of the game.

NIEL WALD: Well, the only proposal for which a case was being made was evaporation. You have to get really this far at this stage in the game.

JOSEPH DiNUNNO: Yes, but you're saying we don't need to make a decision. Nobody has really made a case that well, it's more than that. It's also that we have an ideal method now. If we have an ideal method now, then the case for going ahead would be a lot easier. So it's a combination of both the timing and the methodology. So I think this motion does state it, and maybe our discussion will clarify it for anyone who is confused.

THOMAS GERUSKY: I am concerned about an indefinite postponement of a decision. I mean I just don't know. I don't want that water on the island for 35 or 40 years and have to worry about it for that long.

NIEL WALD: This gives GPU the option of coming back with a better proposal or better justification for moving it.

THOMAS SMITHGALL: I voted against the first proposal on evaporation because I didn't want evaporation. Now you're going to ask me to put evaporation back in again. I can't support that. That's what you're asking me to do.

My vote on evaporation was based on the fact that I didn't want any environmental releases in this area, including evaporation. You're asking me now to make a better case for it and then I'll vote for it. My confusion is that you're asking for status quo, but then you're asking me to vote for evaporation.

NIEL WALD: I'm asking you to consider the case for moving ahead and then the best option if there is enough justification to move ahead.

If the conclusion were that the stainless steel tanks will self-destruct and melt in five years and evaporation is the best way to get rid of the water with the other option being to release it as it is, 2 million gallons into the environment, you might want to consider evaporation. I can't close out the possibility if the justification is there.

I think the point that I'm trying to make is that right now I don't think the justification is there to outweigh the concerns. I think the justification has to be there, but I don't want to close out any option when the justification is sufficient. I can't be absolute about saying this one --

ARTHUR MORRIS: It's okay to debate your feelings, but unless you suggest an amendment to delete something, we're really not going to move forward on it.

THOMAS SMITHGALL: I make an amendment to delete evaporation from the proposal.

ARTHUR MORRIS: Okay. So the wording would say until a stronger case can be made for definitive action on a more desirable alternative is what you would suggest it would say.
Do we have a second to that motion?

JOHN LEUTZELSCHWAB: I'll second that.

ARTHUR MORRIS: Could we move very quickly to a vote on this, please.
If you object, please let me know.
There is an original motion that reads, and I will take the time to read the original and what this one is.
Maintain the status quo until a stronger case can be made for definitive action, including evaporation or a more desirable alternative.
If you would vote for the amendment you would be voting to eliminate the wording of the evaporation such that it would then read:
Maintain the status quo until a stronger case can be made for definitive action on a more desirable alternative.
If you vote yes to that, you are deleting any reference to evaporation. Even if you vote yes and it passes, we still have to vote on the main motion then without evaporation in it. Understand that.
All those in favor of the motion to delete the word "evaporation" basically is what we're saying, please say Aye.
(Chorus of Ayes)

ARTHUR MORRIS: I hear two very weak Ayes.
(The word Aye emphasized)
Thank you.
(Laughter)
All those opposed to the motion please say No.
(Chorus of Noes)
Okay. The Noes have it and evaporation is still in the motion.
Now we have before us the main motion and may we vote on this main motion at this point.
All those in favor of the motion, and I'm going to take the time to read it so nobody can say they misunderstood it.
Maintain the status quo until a stronger case can be made for definitive action including evaporation or a more desirable alternative.
All those in favor of that motion please say Aye.
(Chorus of Ayes)
All those opposed say No.
(Chorus of Noes)
Again, the Ayes have it.

FROM THE FLOOR: We want to see their hands.

ARTHUR MORRIS: You want to see their hands? Okay, we'll do it.
All those in favor of the motion please signify by raising your right hand.
(Show of hands)
Five people are in favor of that motion.
Those that are opposed to the motion, please raise your hands.
(Show of hands)
Four people are opposed to the motion.
It's five to four.

FROM THE FLOOR: How about the Chair.

ARTHUR MORRIS: You want the Chair to vote? The Chair doesn't have to vote, but the Chair can vote on this. Let me just think about this for a second.
(Laughter)
I was thinking I wasn't going to need to.
If I have to vote, I will vote No on the motion, and I know this probably goofs things up, and the reason for voting -- I'm going to vote No. That's my vote. I shouldn't give a reason.
Well, if somebody wants to object to my -- I voted as I did in the previous one, and if somebody wants to make a technical complaint on that, fine, but with the Chair voting it's five to five, which I think I have the choice to do when it's a deciding vote, which in this case it was.
The motion is defeated by five to five. So we do not have a motion before us.
I voted no quite frankly because you say maintain the status quo. I said in my statement that I cannot support that. Personally I just can't. I think it's wrong.

FREDERICK RICE: Can we use the word "any option" rather than --

ARTHUR MORRIS: Well, realize, the wording that Tom Smithgall attempted to put in here was that specific thing, a more desirable alternative. It did not rule out in my mind evaporation. It might have in his. Niel wanted it to be clear that evaporation was still an option because he felt that he didn't want to send the wrong message I think. So he wanted to leave it in as an option.
Right now we don't have anything unless somebody wants to make a motion.

THOMAS SMITHGALL: The amendment that was defeated eliminating the word "evaporation" has to be taken in the context of what this woman is putting down on tape and is going to come in our transcript when we voted about the evaporation issue at the outset.
We all have different reasons for not supporting the evaporation proposal, but it seems inconsistent to say no, I'm not favoring evaporation, but then say you want to put it back in in another vote. I can't support it that way.

ARTHUR MORRIS: From your standpoint I understand that clearly, and I understand what Niel is saying, too. Niel is indicating that his vote against evaporation earlier was not ultimately against it but against it at this time because he feels that more information needs to be available.
So he wanted to include that in a motion that gave that message and the motion lost. So he wasn't successful in that.

ELIZABETH MARSHALL: If members of the Commission read the transcript, the whole transcript of this meeting, including the comments that were made that were brought to our meeting, they will hear some of the scientists who gave their opinion felt about evaporation.
It seems to me that if they can counter some of those arguments and make a better case for it that would convince people in this area, that perhaps it could be brought up again.
I'm not saying that it should be ruled out forever because certainly there are hazards involved with almost anything you do with it. It is a genie in a bottle.

ARTHUR MORRIS: Well, Elizabeth, if somebody can put that in the form of a motion, too. I feel that we should not as a panel expect the Commissioners to read the whole transcript or we are not passing along to them the reflection of the public in ourselves.
That is why I think people here have attempted to give at least some direction other than no to evaporation.

ELIZABETH MARSHALL: We have heard from some objective scientists, and as far as I know they are objective and not subjective, and they are well established people. So I don't think that we should turn a deaf ear to them. Technology does make mistakes. Then years from now we may find that the evaporation of this water has had a bad effect in spite of what evidence there may be in the environmental impact statement.
I think that we have a right to reflect the genuine concerns that our citizens have and that we have because we have heard you might say another side of the aisle.
The NRC depends a lot for their information on the licensee, and the licensee does have a conflict of interest. I guess perhaps that's why we're here because we are a cushion between the conflict of interest and the public.

ARTHUR MORRIS: Does any member of the panel want to offer any comment on the longevity of the storage on the island?
I'm not talking about in years, but is there an interest on the panel to reflect any kind of opinion on whether this should be long-term storage as water on the island or not?
Is there a sense of the panel on that?

ELIZABETH MARSHALL: I think the panel might urge the NRC to consider appropriate action in the near future as to what alternative options might be wise. And maybe we shouldn't say alternative options, but we should say to make a better case for evaporation or to suggest the next desirable option.

ARTHUR MORRIS: But, Elizabeth, we just did that. I mean basically we said to them if it would have passed and it was defeated, that they've got to make a better case for evaporation or some other more desirable alternative. That's really what the message was and it was defeated.
I guess what I'm looking at is since that lost, there has been some sense expressed by individuals that voted for the original motion to deny the evaporation option at this time, that they were concerned about the status quo forever. I mean I think I've heard that, and all I'm saying is there a sense of this panel to make some kind of comment to the NRC as to whether we feel that there is a problem for the water to remain indefinitely on the island or is that a concern or is it not a concern? I think we need to give some sense.

ELIZABETH MARSHALL: It's definitely a concern and perhaps our motion should state that.

ARTHUR MORRIS: Well then somebody should put that in the form a motion if that's the feeling of the panel and we'll decide whether it's something we want to recommend or not.
Again, I've sensed as Chair that there is a concern on the indefinite storage of water on the island.

ELIZABETH MARSHALL: Well, perhaps we should have a motion that would say it is the concern of the panel that the water not be stored on the island, and that -- for a lengthy --

ARTHUR MORRIS: How about indefinite period?

ELIZABETH MARSHALL: For an indefinite period, and that other alternatives, or other options be considered or that a new -- what was it, a stronger case for evaporation be presented.

ARTHUR MORRIS: Elizabeth, we voted a very similar motion down. If you want to make that motion, fine, but I'm hearing --

ELIZABETH MARSHALL: You're concerned about the time limits. We were not emphasizing that, how long it was there.

ARTHUR MORRIS: But the concern of the panel that it not be stored on the island indefinitely could be an action. You don't necessarily have to say -- I mean obviously implied in that is that you've got to come up with another option. I don't know that you have to go further than that unless you want to. If you are suggesting that more options be considered, that's fine, too, whatever you want.
I just sense that if you add onto that evaporation action you're going to be back to five to five.

ELIZABETH MARSHALL: Then you're not for making any recommendations but just making a statement.

ARTHUR MORRIS: This panel has said they don't want to touch evaporation at this point. That's basically what I've heard then saying, they don't want to include it in a motion. Whether you like it or not, they have said that, or at least five to five they said it.
I think a motion with evaporation in it is doomed to fail, and I'm suggesting in order to make progress that we might want to have the panel express that the water not be stored indefinitely, and I think that's the sense of it.

ELIZABETH MARSHALL: That's all right. I make that motion.

ARTHUR MORRIS: The question is do we have a second to the motion.

ELIZABETH MARSHALL: The concern of the panel that the water --

ARTHUR MORRIS: The concern of the panel that the water not be stored on the island indefinitely.

WILLIAM TRAVERS: What's indefinite? I'm sorry. When this panel started it was only supported to be on the island for five years.

ARTHUR MORRIS: Indefinitely means they should not just assume that that is a long-term solution is storage on the island. The sense of the panel is that is not the solution if that is what you vote for here.
Now somebody would say well, what is the length of time. I think to get into a debate on that again is going to be a problem and you're going to talk two years, five years, ten years. I just think that's a problem for the panel to come to grips with.

ELIZABETH MARSHALL: Could we say a timely solution?

ARTHUR MORRIS: Well, we get back to what is the time.
John.

JOHN LEUTZELSCHWAB: I think we're looking for a sense and not for any directions. The NRC is just going to say well, what do you feel. So I think this "indefinitely" would at least give them something to work with.

ELIZABETH MARSHALL: Yes.

JOSEPH DiNUNNO: I think you have given them that. You have a five to five vote on a proposition before and that gives them a sense, and this I think reflects the feeling out there and it reflects a counter feeling and I don't think you're going to get much further than that.
I don't think you're going to get any unanimous opinion on much of anything beyond that point other than the fact that there has to be a solution, and it's a matter of whether you make it now or you make it later. That's what we're really talking about, and putting it off doesn't do -- if I could see sitting here that there were any alternatives that have not been examined and looked like they would come down the pike in two years, I would be right with you, but I don't.

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I think they have done an exhaustive look at alternatives, and I can't see them coming up with anything within two years that is going to add very much to this.

ARTHUR MORRIS: But I do feel, Joe, a sense from the panel that this is not a permanent solution. In fact, the concern of the panel that the water not be stored on the island indefinitely is a sense that I feel is important to offer if we have such a sense.
Tom.

THOMAS GERUSKY: GPU could submit a proposed change to their tech specs to allow release of the water to the river, and we haven't done anything about that issue. They could go right on and release the water to the river. What we have done is prevented them from doing maybe a better option. I just don't think that that vote, the vote that we took against one option is going to solve this problem, and that's what I'm concerned with.
I think we should have looked at the total picture. I don't think you want it released to the river either. You should have said that in the motion if that's what you wanted.
(Applause)
What you did is probably authorize them to dispose of it in the river, and I'm opposed to that. I just don't think that is a good sense.

ARTHUR MORRIS: I voted against the motion. So if you're looking at me when you say that, it was not my motion. I voted against both of them, and I agree with you. That is a considerable concern of mine, and I've mentioned that to the members of the public and to members of this panel on more than on occasion.

ELIZABETH MARSHALL: It was my understanding though that we were voting against their proposal to evaporate.

ARTHUR MORRIS: That's right.

ELIZABETH MARSHALL: That's what they proposed.

ARTHUR MORRIS: We supported the EIS, first of all, accepted it. We said it's acceptable. Then we said the evaporation was not acceptable. And then we defeated a motion to maintain the status quo, et cetera. We defeated that.
So really at this point there has been no word to the dumping of the water into the river.

THOMAS SMITHGALL: Do you want a sense of that?
(Laughter)

ARTHUR MORRIS: Well, you know, does this panel want to give a sense of that? If so, then you had better give a motion.

FREDERICK RICE: I thought that was included --

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ARTHUR MORRIS: It was not included. If you see the record, it was read 18 times and it was not included.

NIEL WALD: The motion that failed would have precluded action without a better justification, and that also implies that it's not long-term, indefinite future status quo on the island.

ARTHUR MORRIS: To me when you say maintain that status quo until a stronger case -- status quo to me is the governing item, and that's why I voted against it.
If you would have said as part of that something about storage on the island indefinitely is not the solution, but that we would maintain the status quo until a stronger and so on, then I would have voted for that and it would have passed six to four. That would have sold me enough or at least the statement was being made that we shouldn't store it on island permanently.

ELIZABETH MARSHALL: Can't we come up with on motion that's going to cover all of this?

ARTHUR MORRIS: Well, I think that is what Niel is attempting to do, and what he's doing, if I could be clear, is moving the sense of the concern of the panel that the water not be stored on the island indefinitely period, maintain the status quo until a stronger case can be made for definitive action, including evaporation, or a more desirable alternative.
That was what I think you were suggesting now as a motion.
Do we have a second to that?

THOMAS GERUSKY: I don't know what you said?

ARTHUR MORRIS: Pardon?

THOMAS GERUSKY: I don't know what you said. I mean I've heard so many words misused tonight in discussions on individual motions, that I would like to make a motion that we adjourn.
(Laughter)

ARTHUR MORRIS: You just said that you were concerned that we haven't spoke to the water dumping issue, and now you sit here and say you want to adjourn.

THOMAS GERUSKY: I know, but I don't think we're going to do that. I just can't see us doing that properly, and I don't think any more votes are going to solve that problem, except a vote to adjourn.

FRANK STANDERFER: I wonder if it would help the panel for me to explain --

ARTHUR MORRIS: Come up to the mike, Frank. Frank, I only want one or two minutes, please.

FRANK STANDERFER: It won't take very long.

ARTHUR MORRIS: That's all we want.

FRANK STANDERFER: The panel has been struggling over this for three months, and we struggled over it for three months last spring. This started in January of last year when the Commission asked us to make a recommendation.

So in being responsive to their request we -- by July -- we said that we could make a recommendation by July.

We looked at the options and found four practical options, to store it on the island, put it in the river, make a big block of concrete out of it and store it on the island or evaporate it.

Then we sort through those this way. We decided that we would not recommend to put it in the river. It was clearly an unacceptable option to the people in this area.

Then we decided that we wanted to dispose of wastes from the island when they were available for disposal and we didn't want to store that water on the island.

That left either a big block of concrete on the island or evaporation and we decided that we did not want to make the island into a low-level waste dump, and that left us with one option, which was the evaporation option. All of the options comply with regulatory requirements at the present time. So possibly the panel could take a position on some of the issues, such as river disposal and whether it should be stored on the island. That is how we sorted through it.

ARTHUR MORRIS: Thank you.

ELIZABETH MARSHALL: Mr. Standerfer, why did consider making one great, huge concrete block rather than a whole lot of smaller ones that might be moved?

FRANK STANDERFER: You can make small ones or big ones. That's all the same option. That would be the solidification and storing the material on the island, and we decided that we should not create a low-level waste storage dump on the island.

ELIZABETH MARSHALL: Right, but if you had it say in smaller blocks of concrete, could it not then be moved to the low-level disposal site that we're eventually going to have?

FRANK STANDERFER: Yes, and the price is $35 million and we did not believe that that was economically viable. It will take up a lot of space in the state's dump and I don't think they would want to waste that space on material which is de minimus in radioactive content.

ARTHUR MORRIS: Frank, thank you.

I think at this time truly, and while I indicated before and I think I'm complicating things by indicating a willingness to change my vote, the fact is when a letter goes into the NRC it's going to indicate that this panel by a five-four-one vote voted to oppose the evaporation. I'm going to indicate that by a five to five vote no recommendation was made on that wording that I will not read again.

(Laughter)

That's where things stand at this point, and I'm not going to push or suggest that we get into storing indefinitely if the panel doesn't have a sense.

My biggest concern at this point is I personally do not want to leave without giving a sense on the dumping of the water issue into the river, and I would ask that we at least close that loop because I think -- I hadn't pushed for us to do that because I thought it was clear, but maybe we want to make it perfectly clear.

I would ask that somebody make that motion at least to clear that point up.

FREDERICK RICE: I so move.

THOMAS SMITHGALL: Second.

ARTHUR MORRIS: It's been moved and seconded that the panel express opposition to the dumping of the water option into the river.

All those in favor of that motion signify by saying Aye.

(Chorus of Ayes)

Is there anybody opposed to the motion?

(No response)

So it's unanimous.

Is there any other motion that anybody would like to make, or any other comments you feel we should be making in general and you would like the Chair to express without being formal about it in a letter to the NRC? Should I be at liberty to express some of the public concerns that we've heard at the meeting?

JOSEPH DiNUNNO: Sure.

ARTHUR MORRIS: Okay. I will do that.

Other than that, I feel that we really have concluded action tonight on the purpose for the meeting.

[Discussion and adjourned]

APPENDIX B

CONTRIBUTORS TO THE SUPPLEMENT

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CONTRIBUTORS TO THE SUPPLEMENT

The overall responsibility for the preparation of this supplement was assigned to the Three Mile Island Project Directorate of the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. The statement was prepared by members of the TMI Directorate with substantial assistance from other NRC components and the Pacific Northwest Laboratory. The major contributors to the draft supplement, their affiliations, and function or expertise are listed below.

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(a) The Pacific Northwest Laboratory is operated for the U.S. Department of Energy by the Battelle Memorial Institute.

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APPENDIX C

CALCULATION OF RADIATION DOSES FROM WATERBORNE AND AIRBORNE PATHWAYS

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CALCULATION OF RADIATION DOSES FROM WATERBORNE AND AIRBORNE PATHWAYS

This appendix contains the methodologies, assumptions, and parameters used in the calculation of the radiation exposure to the public. The pathways are organized into three groups: waterborne pathways from the TMI site, airborne pathways from the TMI Site, and airborne pathways from the NTS.

C.1 WATERBORNE PATHWAYS

The public radiation doses resulting from the release of accident-generated water to the Susquehanna River were generated by the NRC's LADTAP II computer code (Strenge, Peloquin and Whelan 1986). The LADTAP II generates 50-year dose commitments based on one year of ingestion. For the alternatives where ingestion occurs for a period of longer than one year, it was conservatively assumed that all the material ingested during the entire period of exposure was ingested in one year. Doses were determined for the maximum individual and for the population within a 50-mile (80-kilometer) radius of the power plant.

The pathways considered for doses to the maximally exposed individual and the population were consumption of drinking water and fish from the river, rivershore activities, and boating and swimming in the river. The irrigated farm product/food pathway was not applied to the dose calculations.

The affected population within the 50-mile (80-kilometer) radius numbered 2.2 million people with age group distributions as follows: 71% adults, 11% teenagers, and 18% children. Only 300,000 of the 2.2 million people were assumed to have obtained their drinking water from the river.

Table C.1 contains the consumption and usage rates by the maximum individual for the various pathways. Table C.2 lists the consumption rates for drinking water and river fish used for the population dose calculations. Additional parameters used for the population doses are as follows:

- shoreline usage - 83,000 person-h/yr
- swimming - 120,000 person-h/yr
- boating - 520,000 person-h/yr
- sport fishing (edible) yield - 308,000 lb/yr (68,000 kg/yr)
- commercial fishing yield - none assumed.

The flow rate of the river was assumed to be 34,000 cfs (963 m^3/sec) for all except one of the calculations. The exception was the calculation of dose to the maximally exposed individual from the consumption of fish. For this calculation, a 3,150 cfs (89 m^3/sec) flow rate was used. Since the flow rates

TABLE C.1. Consumption and Usage for the Maximum Individual

Pathway	Target	Rate
Fish	Infant	0 lb/yr (0 kg/yr)
	Child	15 lb/yr (6.9 kg/yr)
	Teenager	35 lb/yr (16 kg/yr)
	Adult	46 lb/yr (21 kg/yr)
Drinking Water	Infant	87 gal/yr (330 L/yr)
	Child	140 gal/yr (510 L/yr)
	Teenager	140 gal/yr (510 L/yr)
	Adult	190 gal/yr (710 L/yr)
Shoreline Use	Infant	0 h/yr
	Child	14 h/yr
	Teenager	67 h/yr
	Adult	12 h/yr
Boating	All	0 h/yr
Swimming	All	0 h/yr

TABLE C.2. Consumption Rates for Population Doses

Pathway	Target	Rate
Fish	Child	4.8 lb/yr (2.2 kg/yr)
	Teenager	12 lb/yr (5.2 kg/yr)
	Adult	15 lb/yr (6.9 kg/yr)
Drinking Water	Child	69 gal/yr (260 L/yr)
	Teenager	69 gal/yr (260 L/yr)
	Adult	98 gal/yr (370 L/yr)

of the river were so much larger than the discharge rates, the blowdown dilution had no observable effects on the final doses. The transport time from the plant discharge point to the various targets was neglected during the dose calculations.

In addition to the doses discussed above, doses to the population that consumes shellfish harvested from Chesapeake Bay were also calculated. The accident-generated water was diluted by the river flow of 34,000 cfs (963 m^3/sec). Further dilution by the cooling tower blowdown and dilution in Chesapeake Bay was not considered. An annual shellfish harvest of 72 million pounds (33 million kilograms) was assumed. Assuming an edible fraction of 1/2, the total shellfish consumption would be 36 million pounds (16 million kilograms). The shellfish consumption rates for the average individual are listed in Table C.3, but the harvest was more than could be consumed by the

TABLE C.3. Average Shellfish Consumption Rates

Target	Rate
Child	0.73 lb/yr (0.33 kg/yr)[a]
Teenager	1.6 lb/yr (0.75 kg/yr)[a]
Adult	2.2 lb/yr (1.0 kg/yr)[a]
Maximum Adult	97 lb/yr (44 kg/yr)[b]

(a) NRC (1977).
(b) Rupp, Miller and Bates (1980).

population within 50 miles (80 kilometers) of the power plant. Therefore, the population dose from shellfish consumption is applied to the entire population consuming Chesapeake Bay shellfish.

C.2 AIRBORNE PATHWAYS AT THREE MILE ISLAND

The public radiation doses resulting from atmospheric releases from the TMI site due to treatment and disposal of accident-generated water have been calculated using the GASPAR II computer code (Strenge, Bander and Soldat 1986). The GASPAR code generated 50-year dose commitments based on one year of inhalation or ingestion.

Doses were determined for the maximally exposed individual and for the 2.2 million people (age group distribution: 71% adults, 11% teenagers, and 18% children) living within a 50-mile (80-kilometer) radius of the power plant. The pathways considered for both the maximally exposed individual and the population doses were inhalation, consumption of agricultural products, and external exposure.

The following input parameters were incorporated into the computer runs. Consumption rates for individual members of the population are 434 lb/yr (197 kg/yr), 35 gal/yr (131 L/yr), and 179 lb/yr (81 kg/yr) for vegetables, milk, and meat, respectively. Total annual agricultural production for the 50-mile (80-kilometer) area surrounding the site is 1.2×10^8 lbs (5.32×10^7 kg), 1.4×10^8 gal (5.27×10^8 L), and 1.2×10^8 lbs (5.44×10^7 kg) for vegetables, milk, and beef, respectively.

Specific exposure pathways factions used are:

• leafy vegetables from garden	0.5
• other edibles from garden	1.0
• fraction of time milk cows are on pasture	0.6
• fraction of time beef are on pasture	1.0
• fraction of time milk goats are on pasture	1.0
• milk cow intake from pasture	1.0
• beef intake from pasture	0.8
• milk goat intake from pasture	1.0

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The population distributions were obtained from an internal NRC document by A. Sinisgalli, "1981 Residential Population Estimates 0-80 Kilometers For Nuclear Power Plants." The $\bar{\chi}/Q'$ values were obtained from Appendix W of the PEIS (NRC 1981). The $\bar{\chi}/Q'$ values for the maximally hypothetically exposed individual [assumed to be a child located at the site boundary full time, 0.34 miles (0.55 km) west of the site who consumes goat milk from that site] was 4×10^{-6} sec/m^3 for the heated releases from the stack and 3×10^{-5} sec/m^3 for the ground values. In addition, the absolute humidity for the site is 8.0 g/m^3. No credit for enhanced dilution from building wakes was taken.

Exposure parameters for the calculations that are not specified above are contained in the GASPAR code.

C.3 AIRBORNE PATHWAYS AT THE NEVADA TESTING SITE

The tritium dose to persons living within 50 miles (80 kilometers) of the site of evaporation on the NTS was estimated using both site-specific information and generic parameter values. Site data,(a) including the number of persons and locations, average wind speeds and their frequencies of occurrence in direction, were used in estimating atmospheric dilution factors at each population location following a method from the NCRP (1986). The inhalation dose from the tritium was then determined using an average inhalation rate of 2.81×10^5 ft^3/yr (8000 m^3/yr) and a total body inhalation dose conversion factor of 90 rem/Ci inhaled (Strenge, Bander and Soldat 1986). The population dose from the tritium inhalation was then doubled to include any contribution from the possible ingestion of contaminated vegetables from gardens in the 50-mile (80-kilometer) region.

(a) Letter from S. Black (Environmental Monitoring Standard Laboratory, Las Vegas) dated November 5, 1986, to R. Harty, Pacific Northwest Laboratory. Subject: "Data for EPA AIRDOSE, NTS Wind Data-Yucca Flats." Available in NRC Public Document Room.

APPENDIX D

BASIS FOR TRANSPORTATION ACCIDENT AND TRANSPORTATION COST ESTIMATES

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BASIS FOR TRANSPORTATION ACCIDENT AND TRANSPORTATION COST ESTIMATES

Several of the alternatives for disposal of the accident-generated water involve offsite shipment of the product waste forms. Because of the extremely low radionuclide content of these wastes, no radiological consequences are expected to result from these shipments, including consequences from normal (or incident-free) transport as well as accidents. However, accidents could occur and therefore, nonradiological fatalities and injuries could also occur. The approach, bases, and results of estimating the number of fatalities and injuries for each of the alternatives that involves offsite truck shipments are described in this appendix. The bases and approach to estimating transportation costs are also described.

D.1 TRUCK ACCIDENT FATALITY AND INJURY ESTIMATES

The general approach to estimating the nonradiological impacts of accidents during offsite shipments is to multiply the number of vehicle-kilometers by a fatality (or injury) rate given in units of fatalities (or injuries) per kilometer. The number of vehicle kilometers for each alternative is the product of the number of shipments times the round-trip shipping distance. Accident fatality and injury data, as well as shipping distances, are available for travel in three population zones: rural, suburban, and urban (Cashwell et al. 1986). Therefore, the total fatalities (or injuries) over an entire shipping campaign is the sum of the products of the vehicle kilometers and fatality (or injury) rates in each zone. The basic accident fatality rates, injury rates, and shipping distances used in this study are presented in Table D.1. Only truck transportation is considered. The accident data in Cashwell et al. (1986) were taken from statistics compiled by the Department of Transportation (DOT 1985).

A final calculation was performed to estimate the number of accidents expected for each alternative. This estimate is based on the ratio of the total number of truck accidents in 1983 to the total number of injuries produced by these accidents (DOT 1985). This ratio is 1.18 accidents per injury. To estimate the total number of accidents for each alternative, this ratio is multiplied by the number of injuries that was estimated using the injury rates shown previously.

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TABLE D.1. Basic Truck Transportation, Accident, and Mileage Data (Cashwell et al. 1986)

	Shipment Destination	
	Hanford	NTS
One-Way Shipping Distance (km)		
Rural	3,370	3,330
Suburban	890	820
Urban	29	27
Fatalities/km		
Rural	6.8×10^{-8}	
Suburban	1.7×10^{-8}	
Urban	1.0×10^{-8}	
Injuries/km		
Rural	8.3×10^{-7}	
Suburban	3.9×10^{-7}	
Urban	3.8×10^{-7}	

D.2 TRANSPORTATION COST ESTIMATES

Because of the low radionuclide concentrations in the accident-generated water, it is assumed that all wastes would be classified as LLW and could be shipped as a "non-highway-route-controlled" quantity. Special provisions are required for the higher-activity "highway-route-controlled" quantity shipments that are not needed for the waste products considered in this study. This section describes the approach and bases used to estimate transportation costs and presents the results for each alternative that involves offsite shipments.

A relatively straightforward approach was used to estimate offsite transportation costs. Unit costs for non-highway-route-controlled LLW shipments by truck were taken from McNair et al. (1986). The unit costs for these shipments were given at \$1.90 per mile (\$1.18 per kilometer). This unit cost was multiplied by the total one-way vehicle-miles to estimate the transportation costs for each alternative. McNair et al. (1986) indicated that this rate should be multiplied by only the number of loaded vehicle-miles. The number of one-way vehicle-miles was calculated by multiplying the number of shipments by the one-way shipping distances from TMI to Hanford (2,680 miles or 4,313 kilometers) and from TMI to NTS (2,612 miles or 4,203 kilometers) given by Cashwell et al. (1986). The results of the transportation cost calculations for each alternative that involves offsite shipments are presented in Table D.2.

TABLE D.2. Summary of Transportation Cost Estimates for Alternatives Involving Offsite Shipments

Alternative	Number of Shipments[a]	Transportation Cost, $ Millions
Forced Evaporation, Solidification with Offsite Burial	80 (low) 135 (high)	0.41 0.69
Bulk Liquid Shipment	420	2.1
Onsite Solidification, Burial at Hanford	1,300 (low) 1,600 (high)	6.6 8.1
Shipment of Resin Liners After Retreatment of Accident-Generated Water	61	0.31

(a) In some cases, a range was given for the number of truck shipments.

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Final Report

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Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from March 28, 1979 accident at Three Mile Island Nuclear Station, Unit 2
Final Supplement Dealing With Disposal of Accident-Generated Water

3. LEAVE BLANK

4. DATE REPORT COMPLETED

MONTH	YEAR
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5. AUTHOR(S)
TMI Cleanup Project Directorate

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11a. TYPE OF REPORT
Technical

b. PERIOD COVERED (Inclusive dates)

12. SUPPLEMENTARY NOTES

13. ABSTRACT (200 words or less)

In accordance with the National Environmental Policy Act, the Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Waste for the 1979 Accident at Three Mile Island Nuclear Station, Unit 2 (PEIS) has been supplemented. This supplement updates the environmental evaluation of accident-generated water disposal alternatives published in the PEIS, utilizing more complete and current information, and covering the licensee's proposal to dispose of the water by evaporation to the atmosphere.

The staff concludes that this water can be disposed of without incurring significant environmental impact. The staff's evaluation of a number of disposal alternatives indicates that no alternative is clearly preferable to the others, and that the licensee's proposal method is satisfactory. The risks to the general public from exposure to radioactive effluents from any alternative have been quantitatively estimated and are very small fractions of the estimated normal incidence of cancer fatalities and genetic disorders. The most significant potential impact associated with any disposal alternative is the risk of physical injury associated with transportation accidents. Additionally, no significant impacts to aquatic or terrestrial biotic from any disposal alternative are expected.

14. DOCUMENT ANALYSIS – a. KEYWORDS/DESCRIPTORS

TMI-2, accident-generated water, tritium strontium-90, cesium-137, iodine-129, carbon-14, evaporation, Ssuquehanna River, ion exchange, solidification, low-level waste, onsite disposal, alternatives

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